



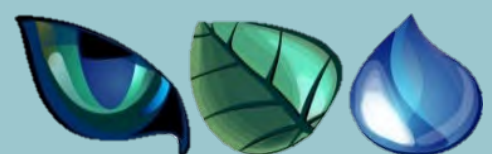
P1000

Pilgangoora Project

Biological Survey

Pilbara, Western Australia

Prepared for
Pilbara Minerals Limited by
Animal Plant Mineral Pty Ltd.



January 2024

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EXECUTIVE SUMMARY

Animal Plant Mineral Pty Ltd (**APM**) was commissioned by Pilbara Minerals Limited to undertake a Detailed flora and vegetation and Targeted terrestrial vertebrate fauna survey for the Pilgangoora Lithium Project, located 84 kilometres (**km**) south-east of Port Hedland in the Pilbara region of Western Australia (**WA**). The area under investigation is referred to herein as the P1000 area or as the Survey Area. The Survey Area is 521 hectares (**ha**).

The field survey was conducted between the 27th of September and 20th October 2023. Rainfall in the year preceding the survey was below average, and the survey was conducted outside of the timing recommended for flora and vegetation in the Eremaean botanical province. The low rainfall preceding survey and the season of survey was a minor constraint to the completeness of the flora survey.

Four vegetation types are described for the Survey Area. No vegetation of conservation significance was recorded, and current extent of regional vegetation units is close to pre-European extent. Vegetation is predominantly in Very Good condition with the main disturbances being low to moderate intensity cattle grazing, vegetation clearing for mining and pastoral activity and a small number of weeds. Completely Degraded areas comprise 2.45 ha or 0.5% of the Survey Area.

No Threatened flora are known to occur in the Survey Area or were recorded during the survey. Two Priority (**P**) 3 flora species – *Triodia chichesterensis* and *Euploca mutica* were recorded. An additional three P3 species were determined likely to occur based upon the availability of suitable habitat and proximity of local records. One of these is a perennial shrub, identifiable from vegetative parts and would have been detectable at the time of survey. The remaining two are annual species, and seasonal conditions were unsuitable for the presence of these species to be detected.

No Declared weeds or Weeds of National Significance were recorded. Two weeds were recorded - *Cenchrus ciliaris*, *Cenchrus setiger*, heavily grazed, limited to the drainage features and in small occurrences of low abundance. These species are common in agricultural areas and are valued by the current pastoral land users.

Four fauna habitats are described for the Survey Area. Spinifex Open Plains is the most common habitat present covering 499 ha (96%) of the Survey Area. In order of prevalence, other habitats present are Sandy Basins followed by Granite Domes then Drainage Lines covering 16 ha (3%), 3 ha (0.6%) and 1 ha (0.2%) of the Survey Area respectively.

There are no previous records of Threatened or Priority fauna species in the Survey Area. Two conservation significant fauna were recorded during the survey from captures on motion sensor cameras. These were the Pilbara Olive Python (listed as Vulnerable under Commonwealth and State legislation), and the Mulgara (considered Priority 4 in Western Australia). An additional six conservation significant fauna are likely to occur based upon local records and the availability of suitable habitat.

Targeted survey for conservation significant fauna identified:

- The presence of Pilbara Olive Python, captured on camera utilising habitat in a termite mound. Termite mounds are not known to provide key habitat for the species, and this is considered a novel finding in this instance. Recognised suitable habitat is also present in the local area consisting of overhangs in the granite domes within the Survey Area, and close by at Baldy Rock. Ephemeral to semi-permanent pools in Chinnamon Creek are between 0.7 and 1.8 km to

the southwest of the Granite Dome overhang habitat in the Survey Area. The combination of overhangs and pools are considered suitable habitat for the species.

- One active Mulgara burrow complex with multiple entrances and fresh diggings. Cameras set on the burrow complex recorded 12 captures of Mulgara between the 8th and 20th October. Other locations were recorded with abandoned burrows, attempted burrows and a scat. All records were made in the Sandy Basin habitat.
- Denning habitat suitable for the Northern Quoll in the overhang sections of the Granite Dome habitat and the tree hollows in the Drainage Line habitat. All habitats are suitable for foraging and dispersal however the highest quality habitats are the Granite Domes and Drainage Line. No evidence of the species was recorded during the survey. The Survey Area contains no habitat critical to the survival of the species, as defined in CoA (2016), and is outside of the 1 km buffer for previously recorded critical habitat.
- Foraging habitat suitable for the Pilbara leaf-nosed Bat, Grey Falcon, Ghost Bat, Greater Bilby and Spectacled Hare-wallaby (mainland) is present and may be used by local populations, however no evidence of their presence was recorded, and therefore the Survey Area is not likely to be important habitat for these species.

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PROJECT TERMS

Abbreviation	Meaning
The Project	Pilgangoora Lithium Project
Survey Area	The 521 ha area that is the subject of this survey, also referred to as P1000

UNITS OF MEASURE

Unit	Measure
%	Percentage
°C	Degrees Celsius
ha	Hectare
km	Kilometre
m	Metre
mm	Millimetre

LIST OF ABBREVIATIONS

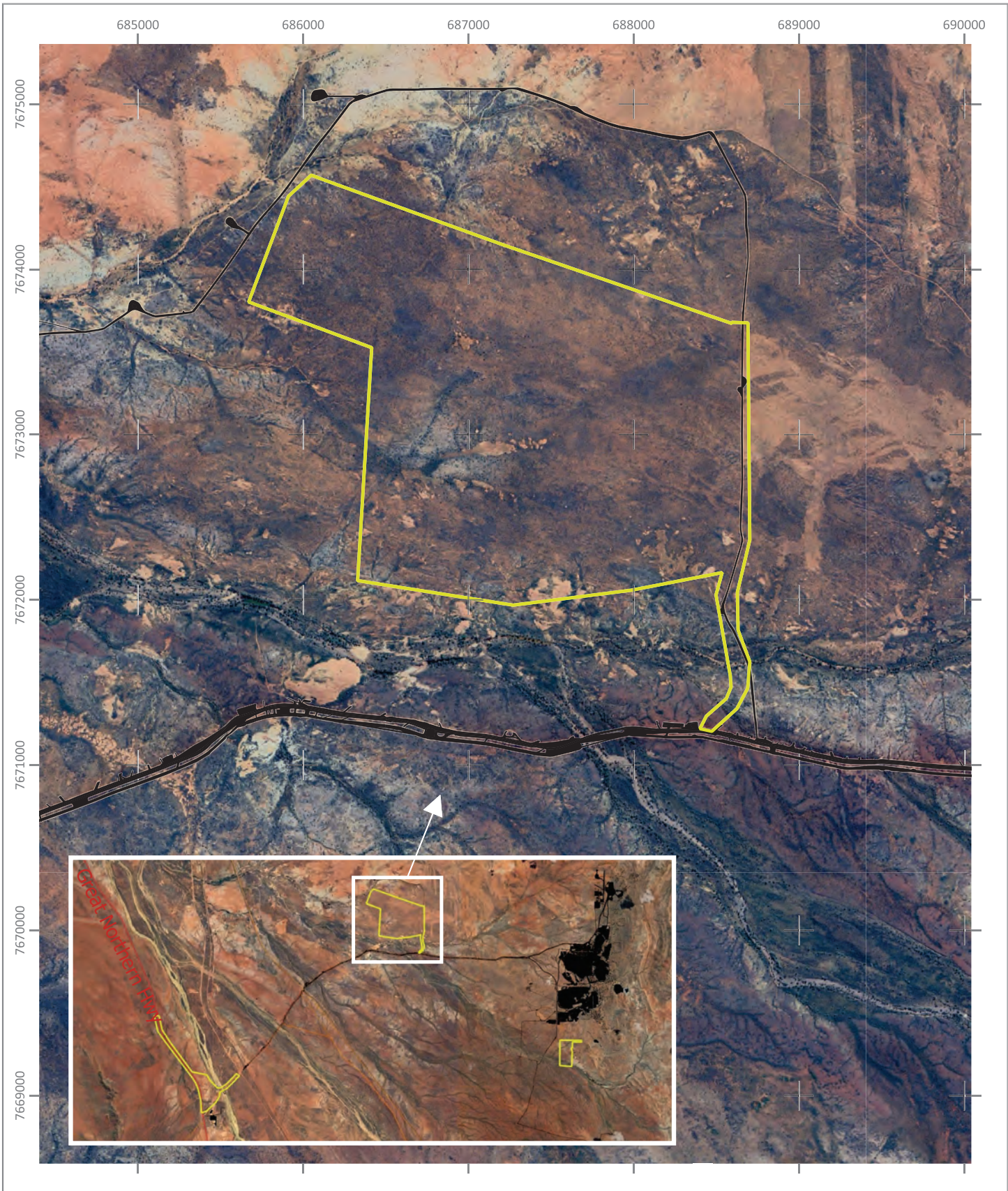
Abbreviation	Meaning
APM	Animal Plant Mineral Pty Ltd
BAM Act	<i>Biosecurity and Agriculture Management Act 2007</i>
BC Act	<i>Biodiversity Conservation Act 2016</i>
BoM	Bureau of Meteorology
DBCA	Department of Biological Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEE	Department of Energy and the Environment
DMIRS	Department of Mines, Industry Regulation and Safety
DWER	Department of Water and Environment Regulation
DPIRD	Department of Primary Industries and Regional Development
EN	Endangered
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESA	Environmentally Sensitive Areas
IBRA	Interim Biogeographic Regionalisation for Australia
IBSA	Index of Biodiversity Surveys for Assessment
MI	Migratory
MNES	Matters of National Environmental Significance
OS	Other Specifically Protected
PEC	Priority Ecological Community
P	Priority

Abbreviation	Meaning
PMST	Protected Matters Search Tool
TEC	Threatened Ecological Community
T	Threatened
VU	Vulnerable
WA	Western Australia
WONS	Weeds of National Significance

1 INTRODUCTION

1.1 PROJECT AND LOCATION

Animal Plant Mineral Pty Ltd (**APM**) was commissioned by Pilbara Minerals Limited to undertake a Detailed flora and vegetation and Targeted terrestrial vertebrate fauna survey for the Pilgangoora Lithium Project, located 84 kilometres (**km**) south-east of Port Hedland in the Pilbara region of Western Australia (**WA**). The area under investigation is referred to herein as the P1000 area or the Survey Area. The Survey Area is 521 hectares (**ha**) and is shown in Figure 1-1.



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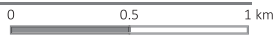
Project Location - P1000

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Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



Legend

- P1000 Survey Area
- Pilgangoora Project



1.2 SCOPE OF WORK

The scope of work includes a Detailed flora and vegetation and Targeted terrestrial vertebrate fauna survey. Survey data accompanies this report in a format suitable for submission to the Index of Biodiversity Surveys for Assessment (**IBSA**) online portal.

1.2.1 Flora and Vegetation

The flora and vegetation survey was conducted in accordance with the Environmental Protection Authority's (**EPA**) *Technical Guidance - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment* (2016) at a Detailed level of assessment.

The aims of the desktop study were to:

- Establish vegetation associations previously determined for the site;
- Identify threatened (**T**) and priority (**P**) flora and ecological communities (**PECs** and **TECs**) previously recorded on site;
- Identify weed species previously determined as present on site, in particular any Declared weeds; and
- Identify potentially suitable habitat for conservation significant flora known from the region, using publicly available regional datasets such as geological, land system, surface water and Groundwater Dependent Ecosystems (**GDE**) mapping products.

The aims of the field survey were to:

- Describe and map the vegetation types present and provide comparisons to locally described types;
- Identify species present on site, including T and P Flora, and weed species in particular any Declared weeds; and
- Identify conservation significant features of the flora and vegetation.

1.2.2 Terrestrial Fauna

The scope of work was to conduct a basic and targeted terrestrial vertebrate survey in accordance with the EPA's fauna guidelines: *Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (2020).

The aims of the desktop study were to:

- Identify T and P Fauna species previously determined as present on-site;
- Identify habitat types previously determined as present on-site regarded as suitable for T and P fauna; and
- Identify introduced species previously determined as present on-site.

The aims of the field survey were to conduct:

- Targeted quoll survey using unbaited camera traps;
- Bat survey using acoustic monitoring devices; and
- Traverses searching for signs of T and P fauna and record habitats suitable for T and P fauna.

2 BACKGROUND AND SUPPORTING INFORMATION

2.1 RELEVANT LEGISLATION AND GUIDANCE

2.1.1 Commonwealth Government EPBC Act

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (**EPBC Act**) is administered by the Department of Climate Change, Energy, the Environment and Water (**DCCEEW**). It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined in the EPBC Act as Matters of National Environmental Significance (**MNES**).

If a project has the potential to significantly impact on MNES it is to be referred to the DCCEEW for determination on whether the matter is a 'controlled action' and therefore requiring assessment.

The EPBC Act provides for the identification and listing of species under several categories listed in Appendix A. The EPBC Act also provides for the development of conservation advice and recovery plans, development of a register of critical habitat, recognition of key threatening processes and the development of threat abatement plans.

2.1.2 Western Australia BC Act

The *Biodiversity Conservation Act 2016* (**BC Act**) provides a statutory basis for the listing of T species, specially protected species, extinct species, TECs, collapsed ecological communities, critical habitat and key threatening processes in WA. The BC Act provides for the listing of T flora and fauna species and ecological communities under specified conservation categories listed in Appendix A. Species and communities listed under the BC Act are protected and require authorisation by the Minister to take or disturb.

Species may also be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest to science. Species of special conservation interest, migratory species and species subject to international agreements are known as Specially Protected Species in the BC Act.

2.1.3 Western Australia Priority species and communities

Flora and fauna species and communities are listed by the Department of Biodiversity, Conservation and Attractions (**DBCA**) as P when they are considered to have a greater level of significance than other native species and communities. This generally occurs where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to T species and communities categories. Whilst P species and communities are not specifically listed in the BC Act, all flora and fauna are protected in WA following the provisions in Part 10 of the BC Act. This protection applies even when a species is not listed as T or specially protected. The categories covering P species and communities are listed in Appendix A.

2.1.4 BAM Act

Plants may be 'Declared' by the Agriculture Protection Board under the *Biosecurity and Agriculture Management Act 2007* (WA) (**BAM Act**). Declared Plants are gazetted under three categories (C1-C3) which define the action required. Details of the definitions of these categories are provided in Appendix A. A declaration may apply to the whole State, to districts, individual properties or even to single paddocks. If a plant is 'Declared', landholders are obliged to control that plant on their properties.

2.1.5 Weeds of National Significance

The DCCEEW, along with the State and Territory governments, has endorsed 32 Weeds of National Significance (**WONS**). Four major criteria were used in determining WONS:

- The invasiveness of a weed species;
- A weed's impact;
- The potential for spread of a weed; and
- Socio-economic and environmental values.

Each WONS has a national strategy and a national coordinator, responsible for implementing the strategy. WONS are regarded as the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts (DAWE 2020).

2.1.6 Guidelines

The terrestrial biological assessment was conducted in accordance with the above Commonwealth and State legislation, as well as EPA requirements for environmental surveys as outlined below:

- *Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA 2020); and
- *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016).

Relevant species-specific survey and assessment guidelines include:

- *Survey Guidelines for Australia's T Bats* (Department of the Environment Water Heritage and the Art (**DEWHA**) 2010).
- *Survey Guidelines for Australia's T Mammals* (Department of Sustainability Environment Water Population and Communities (**DSEWPAC**) 2011); and

Relevant guidance for the preparation of spatial datasets to accompany this report are:

- Guidelines for biological survey and mapped data (Department of the Environment and Energy (**DEE**) 2018); and
- Instructions for the preparation of data packages for IBSA (EPA 2021).

2.2 LAND USE

The Survey Area lies within the Wallareenya pastoral lease (N050365). The underlying current land use is cattle grazing.

Active mining operations and exploration activities occur within the Pilgangoora Lithium Project, with the mining and processing area 7 km to the east.

The Fortescue, Roy Hill and Mount Newman railway lines are between 5 and 8 km to the west and the Great Northern Highway is 12 km to the west.

2.3 CLIMATE

The Pilbara has very hot summers, mild winters and low and variable rainfall. It is classified as hot desert in northern and inland areas and hot grasslands in the north-west. The climate of the Chichester subregion of the Pilbara is described as semi-desert-tropical, receiving 300 millimeters (mm) of rainfall annually (Kendrick and McKenzie, 2001).

The nearest Bureau of Meteorology (BoM) weather station with a long historical record is at Port Hedland Airport (BoM Site Number: 004032), approximately 75 km northeast of the Survey Area. Port Hedland Airport has recorded rainfall from 1942 (80 years), and temperature from 1948 (74 years). The average climate data recorded for the region over these periods is shown in Figure 2-1. Monthly mean maximum temperature ranges from 36.8°C in March and December to 27.4°C in July. Monthly mean rainfall ranges from 89.3 mm in February to 0.9 mm in October, with a mean annual rainfall of 318.5 mm (BoM 2023).

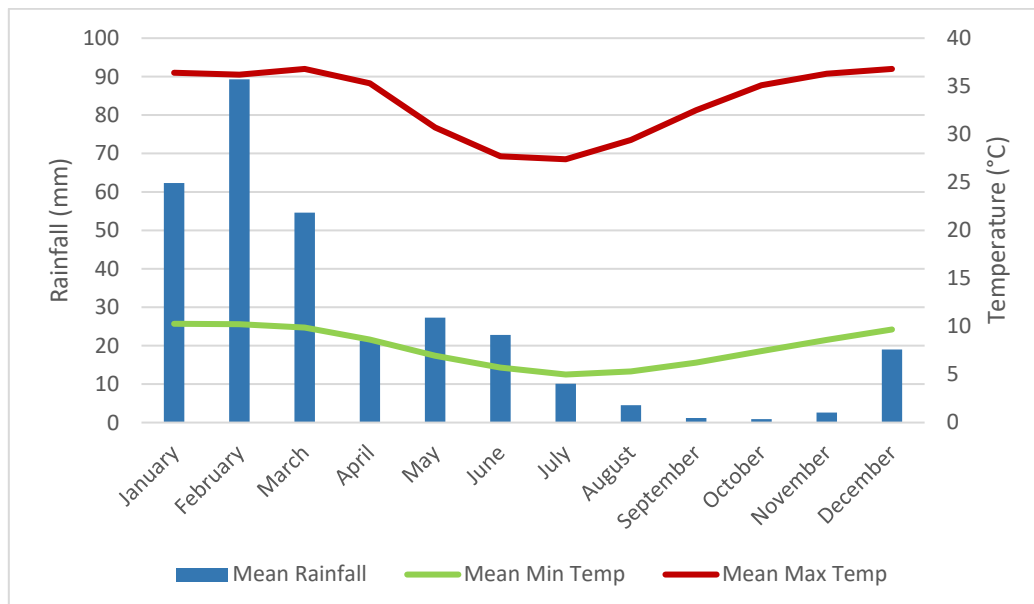


Figure 2-1. Temperature and rainfall averages for Port Hedland Airport weather station (Station No. 004032) (BoM 2023)

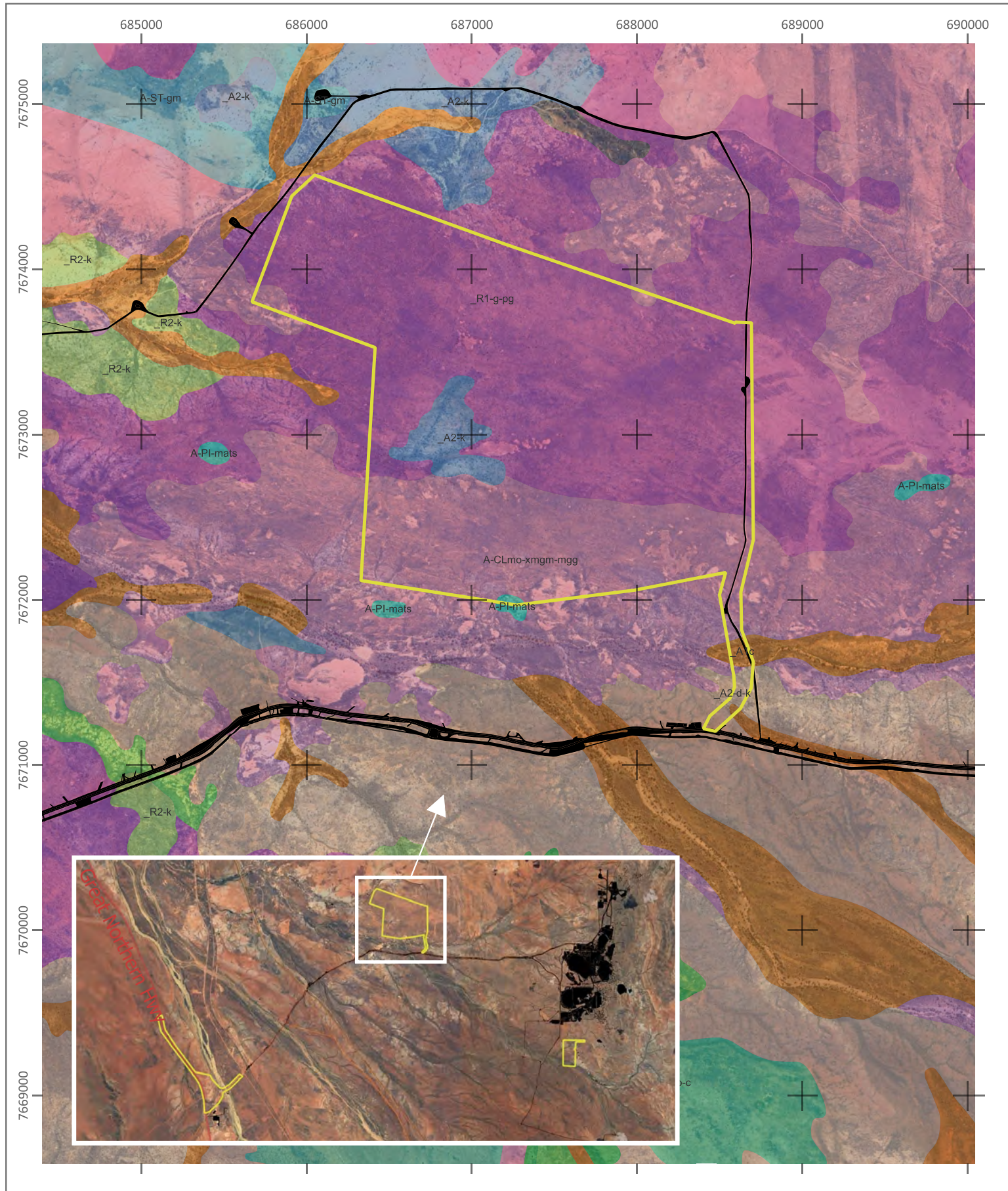
2.4 GEOLOGY

The Pilbara 2014 Geological Information Series dataset (Geological Survey of Western Australia 2014) features a 1:100 000 scale surface geology compilation. The digital layers are based on published maps from the 1994-2005 Pilbara Craton Mapping Project, carried out by the Geological Survey of Western Australia and Geoscience Australia under the North Pilbara National Geoscience Mapping Accord. The Survey Area is within the Wodgina (2655) map area.

The P1000 Survey Area contains the following six geological formations:

- _A1c; Alluvial unit; Sand, silt, and gravel in active drainage channels; includes clay, silt, and sand in poorly defined drainage courses on floodplains; unconsolidated.
- _A2-d-k; Alluvial unit; Partly consolidated alluvial gravel, sand, and silt; local carbonate cement; dissected by present-day drainage.
- _A2-k; Alluvial unit; Alluvial or lacustrine calcrete; massive, nodular, and cavernous limestone; variably silicified; dissected by present-day drainage.
- _R1-g-pg; Residual or relict unit; Residual quartzofeldspathic sand, with quartz and rock fragments; overlying and derived from mass-wasting of granitic rocks; unconsolidated.
- A-CLmo-xmgm-mgg; Motherin Monzogranite; Interleaved metamonzogranite, metagranodiorite, gneiss, and pegmatite; moderately to strongly foliated; intruded by abundant sheets of massive to weakly foliated muscovite-bearing metamonzogranite and pegmatite.
- A-PI-mats; Pilbara Supergroup; Strongly sheared serpentine schist derived from intrusive ultramafic rocks.

The surface geology of the Survey Area is shown in Figure 2-2.



Author: EH Approved: ML Date: 21/11/2023

Geology - P1000

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 Scale: @ A4
 1: 30,000
 Coordinate System: GDA 2020 MGA Zone 50
 Projection: Transverse Mercator

Legend

- Survey Area
- Pilgangoora Project
- _A1c
- _A2-d-k
- _A2-k
- _R1-g-pg
- A-CLmo-xm-gm-mgg
- A-PI-mats



The soils of the Survey Area were mapped by Tille (2006). The Survey Areas are situated in the Fortescue Province, in the western edge of the Nullagine Hills Zone, with influences from the Abydos Plains and Hills Zone.

The Nullagine Hills Zone is characterised by:

“Hills and ranges (with some stony plains) on volcanic and sedimentary rocks of the Pilbara Craton (including the Hamersley Basin). Stony soils with red shallow loams and sands. Spinifex grasslands with kanji and snappy gum. Located in the north-eastern Pilbara around Marble Bar and Nullagine (Tille 2006).”

The Abydos Plains and Hills Zone is characterised by:

“Stony plains (with some hills) on granitic rocks of the Pilbara Craton (East Pilbara Terrane). Red deep sandy duplexes and red shallow loams with stony soils, red sandy earths and red loamy earths. Spinifex grasslands with kanji (and some tussock grasslands). Located in the northern Pilbara between Yandeyarra Community, Bamboo Springs Station, and Marble Bar (Tille 2006).”

2.5 BIOGEOGRAPHIC REGIONALISATION

The Interim Biogeographic Regionalisation for Australia (**IBRA**, version 7) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna, and climate characteristics (Thackway and Cresswell 1995). The mapping completed by Beard (1975) provides the basis for the IBRA bioregions. IBRA mapping (Version 7), places the Project within the Pilbara Bioregion.

The Pilbara Bioregion is characterised by vast coastal plains and inland mountain ranges with cliffs and deep gorges. Vegetation is predominantly mulga low woodlands or snappy gum over bunch and hummock grasses.

The Pilbara Bioregion is further subdivided into the Chichester (PIL1), Fortescue (PIL2), Hamersley (PIL3) and Roebourne (PIL4) Sub-regions. The Project lies entirely within the Chichester Sub-region of the Pilbara Bioregion.

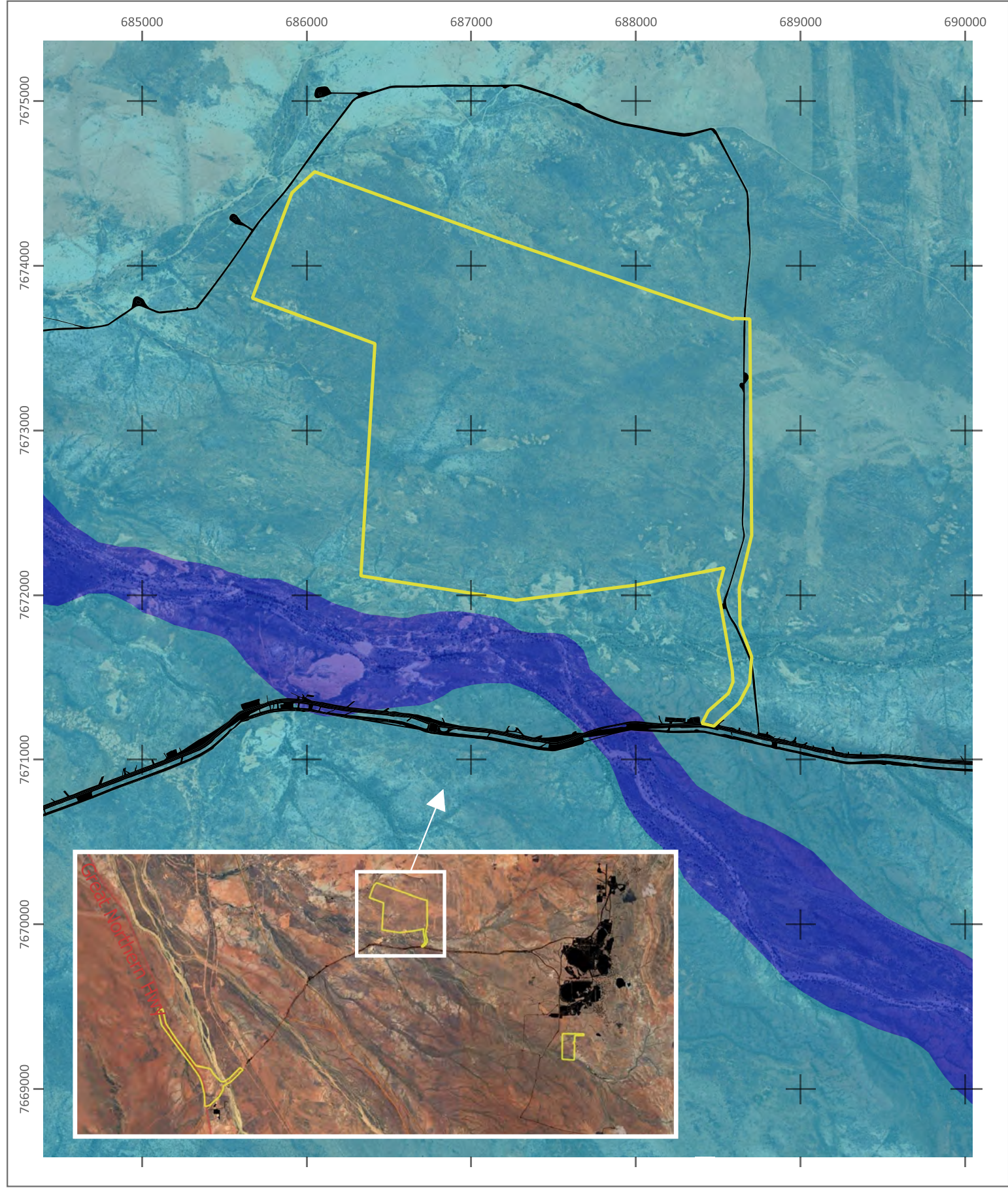
The Chichester Sub-region comprises the northern section of the Pilbara Craton and is comprised of undulating Archaean granite and basalt plains and includes significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges (Kendrick and McKenzie, 2001).

2.6 LAND SYSTEMS

Land Systems of the Pilbara region are described by van Vreeswyk *et al.* (2004). Mapping of Land Systems is available from Department of Primary Industry and Regional Development (**DPIRD**, 2019a). The Survey Area falls within one soil landscape system, Macroy, as listed in Table 2-1 and illustrated in Figure 2-3.

Table 2-1. Land System


Land System	Geology	Description
Macroy	Level to gently undulating stony and gritty surfaced plains with occasional granite tor fields and domes and closely to moderately spaced dendritic tributary drainage floors, relief up to 25 metres (m)	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex grasslands



Author: EH Approved: ML Date: 21/11/2023


Land Systems - P1000

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2-3

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Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



Legend

- Survey Area
- Pilgangoora Project
- Macroy System
- River System



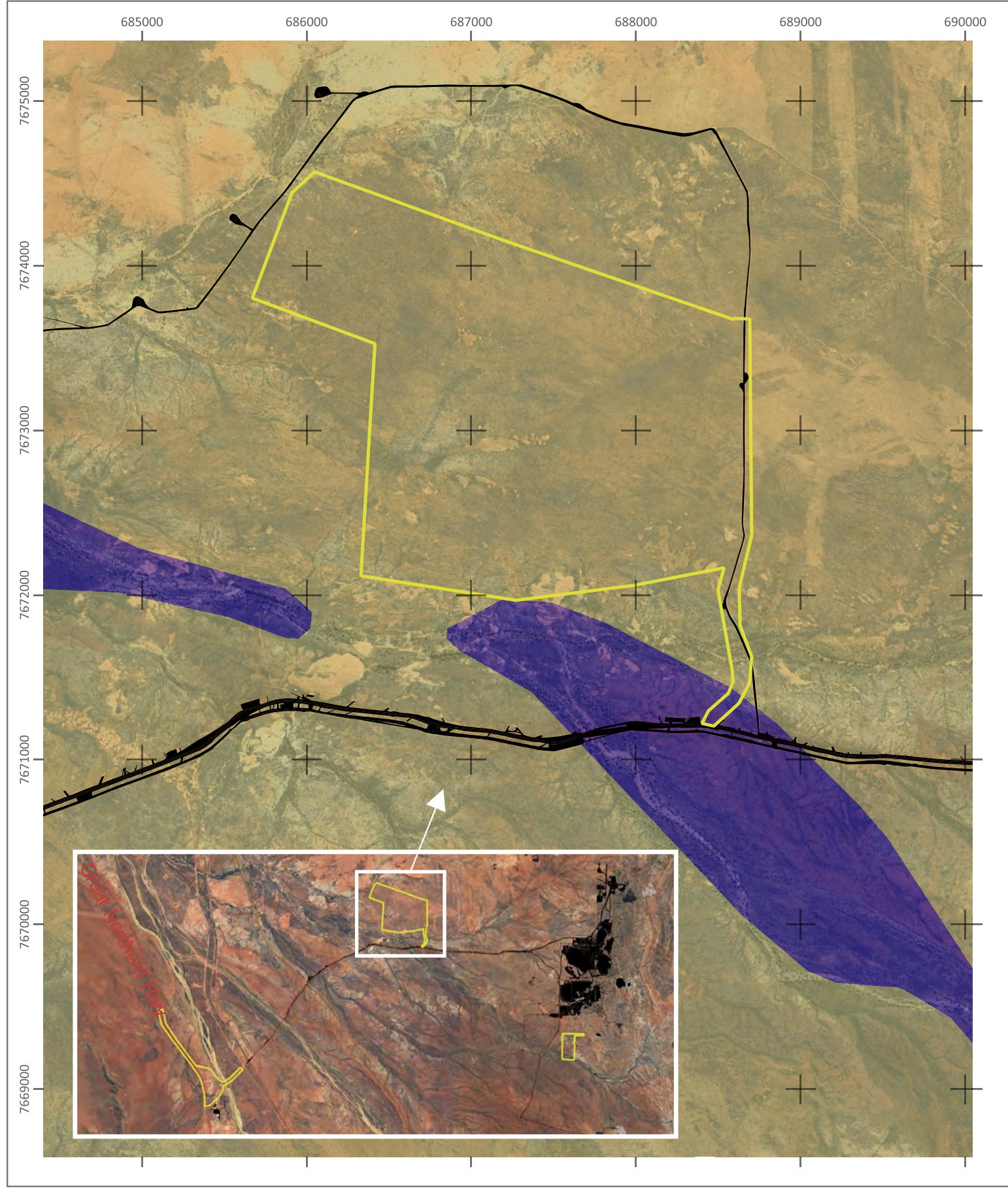
2.7 REGIONAL VEGETATION

The Survey Area is located within the Eremaean Botanical Province and contains two pre-European Beard vegetation association of the Abydos Plain – Chichester System as shown in Figure 2-4 (DPIRD 2019b). The remaining extent of these vegetation associations is outlined in the most recent DBCA Statewide Vegetation Statistics table dated 2018 and summarised in Table 2-2 below.

Vegetation associations within and nearby the Survey Area have over 99% pre-European Vegetation extent remaining. Conservation significance ranking of vegetation associations occurring within and nearby the Survey Area are of 'Least Concern'.

Table 2-2 Pre-European Beard Vegetation Associations


Unit	Vegetation Description	Pre-European Extent (ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent within DBCA Managed Lands (%)
93	Hummock grassland with scattered shrubs or mallee <i>Triodia</i> spp. <i>Acacia</i> spp., <i>Grevillea</i> spp. <i>Eucalyptus</i> spp.	3,044,310	3,040,641	99.88	1.96
619	Riverine; rivergum <i>E. camaldulensis</i>	119,374	118,205	99.02	0.2



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Pre European Vegetation - P1000

Prepared for:




2-4

Scale: @ A4
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Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



Legend

- Survey Area
- Pilgangoora Project
- 93
- 619



2.8 ENVIRONMENTALLY SIGNIFICANT AREAS

2.8.1 Conservation Estate

The Western Australian Conservation Estate includes land and waters vested in the Conservation and Parks Commission under the *Conservation and Land Management Act 1984*. The Conservation Estate is managed by the Parks and Wildlife Service of DBCA to protect WA's biodiversity, and includes National Parks, Nature Reserves, Conservation Reserves, and other areas managed primarily for biodiversity conservation (DEE 2016).

A search of the Collaborative Australian Protected Area Database returned no conservation estates located within 50 km of the Survey Area. The nearest gazetted terrestrial conservation estate is Mungaroon Range, 60-80 km to the south-west of the Survey Area.

2.8.2 Environmentally Sensitive Areas

Environmentally Sensitive Areas (**ESA**) are areas that are defined by the Department of Water and Environment Regulation (**DWER**) (2019) as:

- A declared World Heritage property as defined in s.13 of the EPBC Act;
- An area that is included on the Register of the National Estate, because of its natural heritage value under the *Australian Heritage Council Act 2003*;
- A defined wetland and the area within 50 m of the wetland;
- The area covered by vegetation within 50 m of T flora, to the extent to which the vegetation is continuous with the vegetation in which the T flora is located;
- The area covered by a TEC;
- A Bush Forever site;
- Areas covered by the Gngangara Mound Crown Land Policy and Western Swamp Tortoise Policy;
- Areas covered by lakes, wetlands, and fringing vegetation of the Swan Coastal Plain Lakes Policy, including Southwest Agricultural Zone Wetlands Policy and Swan and Canning Rivers Policy; and
- Protected wetlands as defined in the *Environmental Protection (Southwest Agricultural Zone Wetlands) Policy 1998*.

Environmentally Sensitive Areas can be viewed on the DWER clearing permit system map viewer. There are no ESAs within the Survey Area.

The Australian Wetlands Database includes nationally significant wetlands (as listed in the directory of important wetlands), wetlands listed under the Ramsar convention, wetlands that are representative, rare or unique, or wetlands that are considered of international importance (DEE 2019). The nearest wetlands listed in the Directory of Important Wetlands within 150 km of the Survey Area are the Leslie (Port Hedland) Saltfields System, 80 km to the north, the De Grey River System, 85 km to the north-east, and the Fortescue Marshes, 130 km to the south-west.

3 METHODOLOGY

3.1 DESKTOP STUDY

The desktop study provides background information on the known attributes of flora, vegetation, and fauna of the Survey Area, and in the local surrounding area.

3.1.1 Database Searches

A search for EPBC Act MNES was undertaken using the DCCEEW Protected Matters Search Tool (**PMST**). The PMST identifies EPBC listed flora and fauna species and communities based on predicted distributions of the species and/or their habitat, in conjunction with species records. The PMST may predict the occurrence of a species or community in an area where there are no documented records, or documented records are historic. For this search, the Survey Area was imported into the PMST viewer as the feature area and a buffer of 30 km applied. The conservation codes are described in Appendix A. The results of the PMST search are included in Appendix B.

The DBCA maintains databases for records of T and P species and communities. A request was made for a search of DBCA databases for T and P flora and fauna and the presence of TECs or PECs. A 30 km buffer was applied to the search results from a central coordinate of 696681, 7674607 (GDA 2020, MGA Zone 50).

Flora and Fauna Inventory, including records for Introduced flora and fauna from within 30 km, were obtained from the Dandjoo Biodiversity Data Repository hosted by the DBCA Biodiversity Office (DBCA 2023).

Table 3-1 lists the database searches conducted for the desktop study.

Table 3-1. Database Searches

Attribute	Search Area	Database	Location
Threatened and Priority Ecological Communities	30 km radius	DBCA	Figure 4-2; Section 4.1.1
	30 km radius	PMST	Appendix B
Threatened Flora	30 km radius	DBCA	Figure 4-1; Section 4.1.1
	30 km radius	PMST	Appendix B
Introduced Flora	30 km radius	Dandjoo	Section 4.1.3
Threatened Fauna	30 km radius	DBCA	Figure 5-1; Section 5.1.1
	30 km radius	PMST	Appendix B
Introduced Fauna	30 km radius	Dandjoo	Section 5.1.2

The DBCA fire history database (DBCA 2023) was consulted to identify local fire history.

3.1.2 Literature Review

Flora, vegetation, and terrestrial vertebrate fauna surveys have been conducted in the local area for the Pilgangoora Project, however the P1000 area has not previously been surveyed. The following local surveys were reviewed, and the results incorporated into the Desktop Study where relevant:

- Flora and Fauna Survey Report – Pilgangoora. Prepared on behalf of Altura Mining Limited by Natural Area Consulting, February 2014
- Flora, Vegetation and Fauna Survey Report – Pilgangoora Lithium Project. Prepared on behalf of Altura Mining Limited by Natural Area Consulting, June 2016
- Baseline Vertebrate Fauna Survey, Pilgangoora. Prepared on behalf of Pilbara Minerals Limited by 360 Environmental, May 2016.
- Pilgangoora Project Area – Flora, Vegetation and Fauna Assessment. Prepared on behalf of Pilbara Minerals Limited by MMWC Environmental Pty Ltd, July 2016
- Pilgangoora Access Road Borrow Pits - Flora and Vegetation Assessment. Prepared on behalf of Pilbara Minerals Limited by MMWC Environmental Pty Ltd, July 2016.
- Pityrodia sp. Marble Bar (G. Woodman and D. Coultas GWDC opp 4) Targeted Flora Survey (L45/430 and L45/413). Prepared on behalf of Pilbara Minerals Limited by Ecologia Environmental, 29 June 2017.
- Pilgangoora Lithium Project – M45/1260 Level 1 Fauna and Reconnaissance Flora and Vegetation Assessment. Prepared on behalf of Altura Mining Limited by Ecologia Environmental, 7 July 2018.
- Pilgangoora Project – Stage 2 Expansion Desktop Environmental Assessment. Prepared on behalf of Pilbara Minerals Limited by Ecologia Environmental, 26 October 2018.
- Pilbara Leaf-nosed Bat Survey, Pilgangoora Prepared for Pilbara Minerals Limited by 360 Environmental, November 2015
- Pilbara Leaf-nosed Bat Roost Survey, Pilgangoora Prepared for Pilbara Minerals Limited by 360 Environmental, February 2016
- Northern Quoll Survey on mining tenement M45/1266. Prepared for Pilbara Minerals Limited by Terrestrial Ecosystems, January 2020.
- Pippingarra and Wodgina Roads: Flora and Fauna Survey – Prepared for Iron Bridge Operations Pty Ltd by Ecoscape 10/08/2020.
- Lynas Find Biological Survey - Prepared for Pilbara Minerals Limited by APM, October 2022.
- TSF Option 2 and Option 5 Biological Survey - Prepared for Pilbara Minerals Limited by APM, November 2022.
- Northern Quoll Targeted Survey - Prepared for Pilbara Minerals Limited by APM, March 2023.
- E45/2287 Infill Biological Survey - Prepared for Pilbara Minerals Limited by APM, May 2023.
- Targeted Searches for Conservation Significant Bat Roosts - Prepared for Pilbara Minerals Limited by APM, August 2023.
- Pilgangoora Project Biological Survey- Prepared for Pilbara Minerals Limited by APM, October 2023.

The local and regional area has received a large volume of biological survey over a number of years and multiple seasons.

3.1.3 Likelihood of Occurrence

Threatened and Priority flora, fauna and communities returned from the database searches and literature review were assessed for their likelihood of occurrence within the Survey Area using the likelihood of occurrence criteria listed in Table 3-2.

Table 3-2. Likelihood of occurrence criteria

Likelihood of occurrence	Criteria
Recorded	Identified from database records or field survey as occurring within the Survey Area
Likely	Suitable habitat is present in the Survey Area and the species has previously been recorded within 15 km
Possible	Suitable habitat is present within the Survey Area and the species has previously been recorded between 15 – 30 km of the Survey Area
Unlikely	No suitable habitat is present in the Survey Area

3.2 FIELD SURVEY

3.2.1 Survey Personnel and Timing

The terrestrial vertebrate fauna survey was carried out by Dr Mitchell Ladyman. The flora and vegetation field survey was undertaken by Dr Neil Pettit, Ms Tia Berard and Ms Gidget Neunuebel.

Acoustic analysis and bat call identification was conducted by Dr Kyle Armstrong and Yuki Konishi at Specialised Zoological, a scientific consultancy business that specialises in bats, bioacoustics, and genetic identification. Dr Armstrong has 20 years' experience in environmental consultancy specialising in bats.

Table 3-3 lists the personnel involved in the field survey.

Table 3-3. Field Survey Personnel

Survey Date	Personnel	Experience	Description
28 th September 2023 and 17 th to 20 th October 2023	Dr Mitchell Ladyman	20+ years	Terrestrial vertebrate fauna survey
28 th and 30 th September 2023	Dr Neil Pettit	25+ years	Flora and vegetation survey
	Ms Tia Berard	2 years	
	Ms Gidget Neunuebel	Under instruction	

Autonomous recording devices were installed during the first fauna field survey period and collected in the second survey period.

3.2.2 Survey Conditions

The total summer rainfall prior to survey (1st December 2022 to 28th February 2023) was below average at 97.4 mm compared to 170.6 mm (BoM 2023). The sum of the total rainfall for the period January to October 2023 was 170 mm, which is 58% of the average for the same period (294 mm).

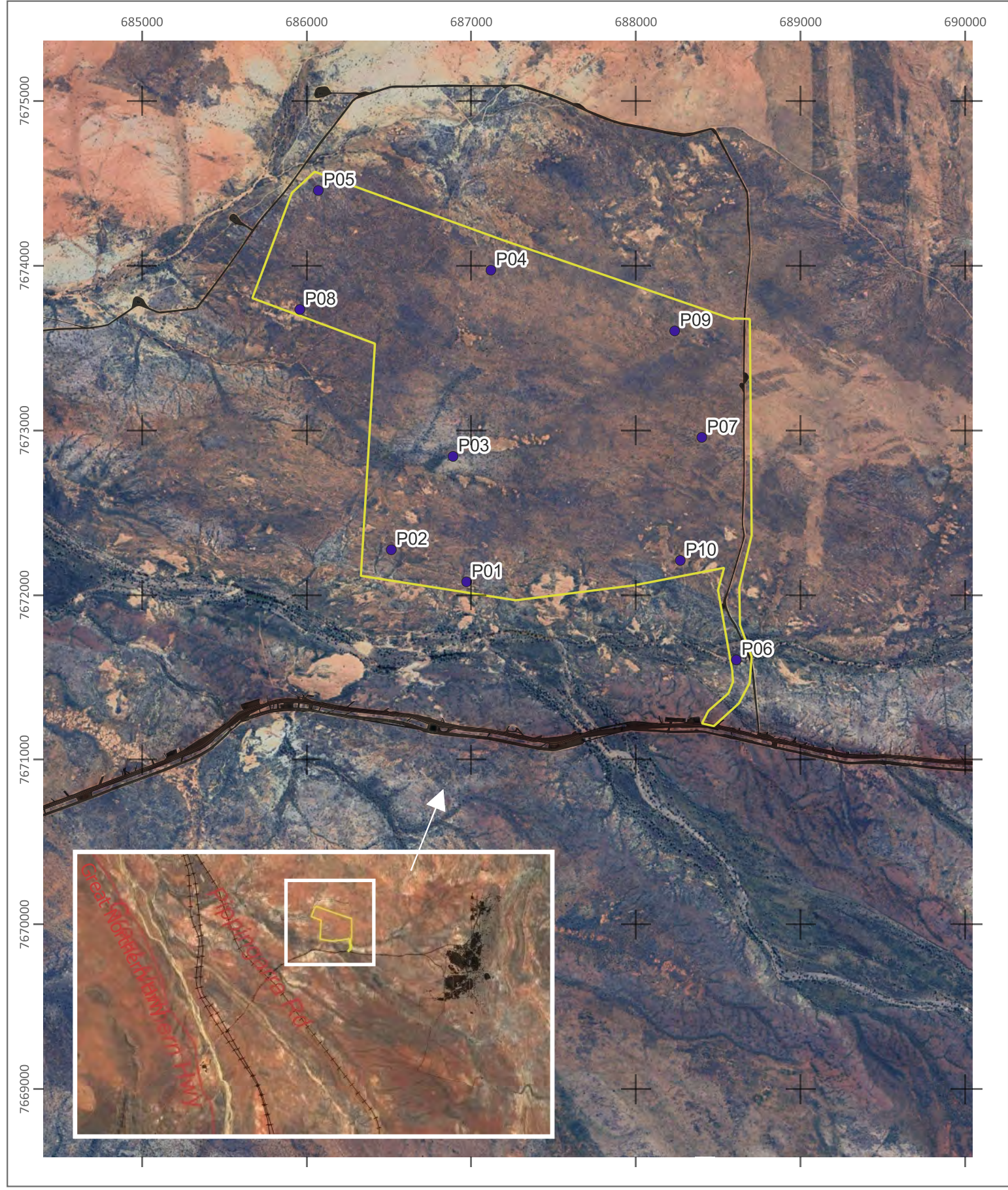
During the survey period, daytime temperatures reached a maximum of between 35.0 and 43.3 °C and a minimum of between 19.1 and 24.0°C overnight, which is typical of the time of year (BoM 2023). No adverse weather conditions occurred that would impact the results of the survey. No rainfall was recorded on the BoM Port Hedland weather station for October and for the duration of the survey.

The Survey Area is within the Eremaean botanical province. Recommended timing for flora and vegetation survey is 6-8 weeks post wet season (March – June) for Primary survey, and a Dry season survey (after winter rainfall if available) for Supplementary survey (EPA 2016). The timing of the field survey is outside of the period recommended for flora and vegetation survey in the region.

Fauna survey timing was within that recommended for reptiles and mammals (EPA 2020).

3.2.3 Flora and Vegetation

A Detailed survey was conducted for flora and vegetation. Vegetation was sampled using ten quadrats of 50 x 50 m (Figure 3-1). Quadrats are vegetation survey plots which are accurately measured out as 50 x 50 m (or an area equivalent to 2500 m²) and marked at the north-west corner using a handheld Global Positioning System (**GPS**) unit.




Author: EH Approved: ML Date: 31/12/2023

Flora Survey Sites

- Legend**
- Flora quadrats
 - P1000 Survey Area
 - Pilgangoora Project




Prepared for:




3-1

Scale: @ A4
1: 30,000



Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



Field data at each survey site was recorded on a pro-forma data sheet and included the parameters listed in Table 3-4. The attributes of Detailed survey sites are provided in Appendix C.

Table 3-4. Parameters recorded at each Detailed site

Variable	Parameters
Collection attributes	Personnel/recorder; date, quadrat dimensions and marking method, site code and georeferenced photographs of the quadrat.
Physical features	Landform, slope, aspect, soil attributes, ground surface cover, litter, rock type and physical attributes.
Location	Coordinates recorded using a hand-held GPS (Garmin) to accuracy approximately ± 5 m.
Vegetation	Dominant growth form, height, cover, and species for the three traditional strata (upper, mid and ground) compatible with NVIS Level V (ESCAVI 2003).
Vegetation condition	Vegetation condition was assessed using the condition rating scale devised by Trudgen (1988).
Disturbance	Level and nature of disturbances (<i>e.g.</i> weed presence, fire, and time since last fire, impacts from grazing, vegetation clearing, erosion).
Flora	List of all species within the quadrat including weeds and listing species average height and cover.

A flora inventory was compiled from taxa listed in Detailed survey sites and from opportunistic floristic collections throughout the Survey Area, with at least one collection made for every taxon encountered. Specimens were identified by an experienced botanical taxonomist in the Western Australia Herbarium (**WAH**) using published reference material. The nomenclature applied is consistent with Florabase (WAH 1998-).

The conservation status of all recorded flora was determined from the DBCA Wildlife Conservation Rare Flora Notice 2022, T and P Flora List 6 October 2022, and the EPBC Act List of T Flora (DCCEEW 2023). The Western Australian Organisms List database was consulted to determine if any are BAM Act Declared Plants (DPIRD 2023), and the Weeds of National Significance list to determine any WONS (DAWE 2020).

The vegetation types were described based on their structure and species composition, as defined by quadrat data, and field observations. Vegetation was mapped in the field using handheld GPS units and aerial photographs, then digitised using GIS software. Vegetation is described at the association level (ESCAVI 2003) and referred to as Vegetation Types (EPA 2016).

Vegetation Condition was assigned using the scale developed for the Eremaean and Northern Botanical Provinces adapted from Trudgen (1988) as recommended in EPA (2016). Table 3-5 lists the six potential categories.

Table 3-5. Vegetation Condition Scale

Vegetation Condition	Eremaean and Northern Botanical Provinces adapted from Trudgen (1988)
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; <i>i.e.</i> areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

Data analysis was applied using the method recommended by EPA (2016). A species by site matrix was prepared using the complete suite of species recorded. The Primer 7 (Clarke and Gorley, 2015), software was used to perform floristic composition vegetation classification. Data was transformed to presence/absence and a resemblance matrix was constructed using the Bray Curtis similarity measure. A cluster analysis was performed using group averages. The SIMPROF routine was used to test the hypothesis that the species and/or abundances are different at each group of sites using 999 permutations and a significance level of 5%.

The completeness of the survey was tested using a species accumulation curve and applying the Michaelis-Menton model to estimate the species richness of the Survey Area.

3.2.4 Fauna

Fauna habitat assessments were performed at six locations. Descriptive data was recorded including soil type, landform, presence of microhabitats, disturbances and images were recorded. Forty-three reference sites were also recorded as mapping notes and site photos, to record the extent/distribution and condition of habitat types throughout an surrounding the Survey Area. Fauna habitat assessment site photos and reference site photos are included in Appendix D.

Targeted search was conducted for direct observation and signs of conservation significant fauna using traverses on foot, with tracklogs recorded on a handheld GPS. Signs include scats, prints, slough skin, scratchings made during foraging and other diggings, burrows and mounds. Georeferenced photos of signs were taken. Traverses were conducted during daylight hours. Traverses covered a linear distance of 26 km and are shown in Figure 3-2.

Motion-triggered cameras were deployed throughout the Survey Area between the 28th September and 1st November 2023. Cameras were generally deployed in pairs or sets around habitat features assessed as being potentially suitable for conservation significant fauna species. Table 3-6 lists the camera locations and confirmed operational days.

Table 3-6. Motion-triggered and time lapse camera setup and duration

Targeted Fauna Habitat	Location (GDA 2020 MGA zone 50)	Camera	Trap nights
Sandy Basin	686616 7672761	MSC016	18
Drainage Line	685873 7671090	MSC021	10
Sandy Basin	686618 7672759	MSC021a	20
Sandy Basin	686616 7672761	MSC021x	20
Sandy Basin	686615 7672760	MSC030	2
Drainage Line	688703 7671603	MSC032	14
Spinifex Open Plains (Termite mound)	687091 7673541	MSC033	14
Granite Dome overhang	687535 7672095	MSC036	14
Granite Dome overhang	687552 7672095	MSC038	14
Drainage Line	685873 7671090	MSC042	12
Spinifex Open Plains (Termite mound)	687065 7673562	MSC043	14
		Total	152

Identifications from camera captures were made as far as necessary to rule out target species, however most fauna captures were determined to species level. Individual captures were counted where a time gap of at least an hour was recorded between captures of the same species unless demarcations were available to definitively identify individuals.

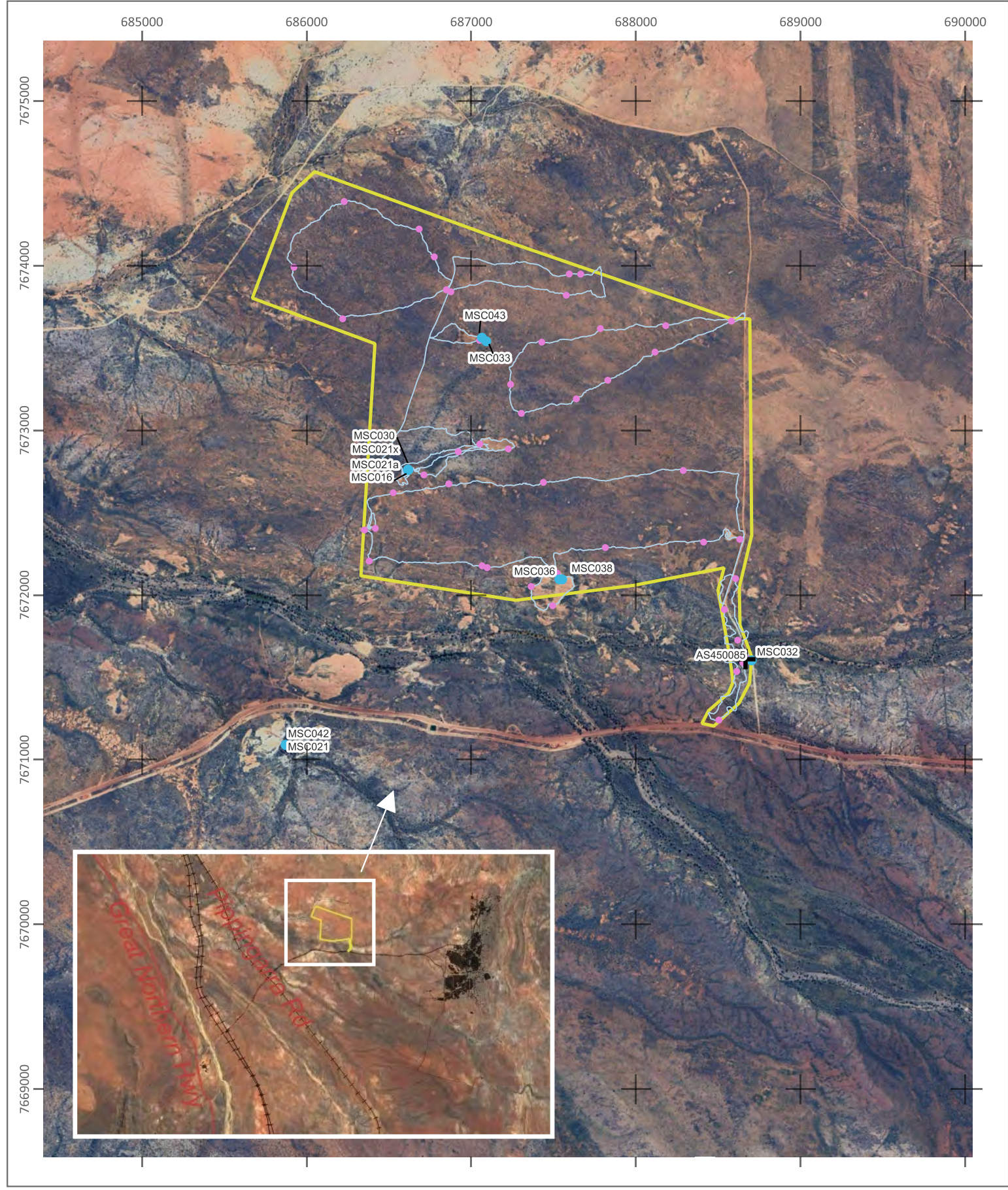
One Anabat Swift acoustic bat recording device was deployed between the 17th and 24th of October 2023 for a total of 7 nights. Table 3-7 lists the acoustic bat recording device deployed, the habitat type targeted, and the number of trap nights.

Bat call analysis was performed by Dr Kyle Armstrong of Specialised Zoological. A technical report with specifications on the analysis method is included as Appendix E. The scope of the analysis was limited to the detection of the conservation significant species Ghost bat *Macroderma gigas* and Pilbara leaf-nosed bat *Rhinionictes aurantia*.

Table 3-7. Acoustic bat recording device location and duration

Habitat	Location (GDA 2020 MGA zone 50)	Acoustic Bat Recorder	Trap nights
Drainage line	688665 7671611	AS450085	7
Total			7


Nomenclature within this report is applied according to the WA Checklist of Terrestrial Vertebrates (Western Australian Museum 2023). Figure 3-2 shows the location of cameras, the acoustic recording device and targeted searches. Detailed fauna habitat assessments were made at the locations where cameras and the acoustic recording device were deployed, and during traverses.



Author: EH Approved: ML Date: 08/01/2024


Fauna Survey Sites

Prepared for:




3-2

Scale: @ A4
1: 30,000



Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



Legend

- P1000 Survey Area
- + Acoustic bat survey
- Motion sensor camera
- Fauna Habitat Assessment and Reference locations
- Traverses



3.3 CONSTRAINTS

Several limitations may arise during field survey EPA (2016 and 2020). These potential survey limitations are listed below in Table 3-8 with comments on the constraint to the outcomes of the survey.

Table 3-8. Survey Constraints

Factor	Impact of survey outcomes
Access problems	Not a constraint. All of the Survey Area was accessed.
Experience levels	Not a constraint. The personnel were suitably qualified.
Scope: Flora and vegetation	Not a constraint. Survey was carried out at a level of Detailed assessment.
Scope: Fauna	Not a constraint. The survey was carried out at a level of Targeted level of assessment, suitable for the size and intensity of the proposed Project and the availability of previous local and regional survey.
Timing, weather, season, cycle	<p>Minor constraint.</p> <p>The Survey Area is within the Eremaean Botanical district. Rainfall in the seasons prior to survey was lower than average. The Flora and Vegetation survey was conducted outside of the recommended survey period (EPA 2016). Conditions were unsuitable for the detection of two annual species of conservation significance (Priority 3) that are considered likely to occur.</p> <p>No inclement weather occurred during the survey period that would impact the detection of target fauna.</p> <p>Survey timing was within that recommended for reptiles and mammals. Conditions were unsuitable for water birds and amphibians, however the assessment of habitat availability for these groups was possible.</p>
Sources of information	Not a constraint. Previous biological reports and database records are available for the locality and region.
Completeness: Flora and vegetation	<p>Minor constraint. All specimens were identified to species level.</p> <p>Modelling indicates the survey captured 68% of the floristic richness present at the time of survey. Due to low rainfall preceding the survey, the presence of annual species was restricted to areas receiving runoff and/or with higher moisture retention. Conditions were unsuitable for the detection of two species of conservation significance that are considered likely to occur – <i>Rothia indica</i> subsp. <i>australis</i> (P3) and <i>Goodenia nuda</i> (P4).</p>
Completeness: Fauna	Not a constraint. The scope was completed. The survey resulted in no ambiguous identifications of bat calls. All motion triggered camera captures were able to be determined to species level excepting one, which was able to be ruled out as being target species and therefore was not a constraint.

4 FLORA AND VEGETATION RESULTS

4.1 DESKTOP STUDY

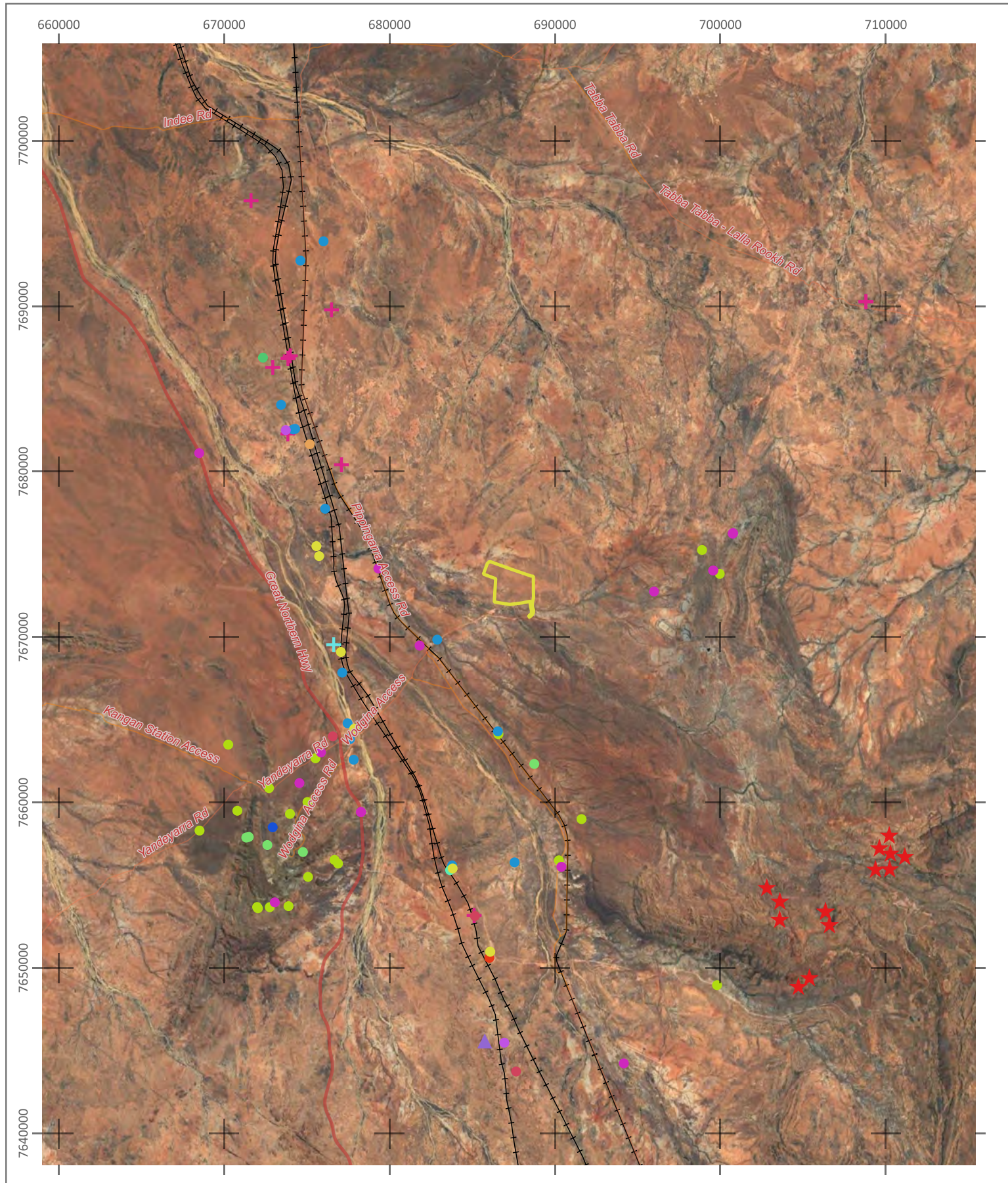
4.1.1 Significant Flora

No T or P Flora listed under the BC Act and/or EPBC Act have been previously recorded within the Survey Area.

One T flora species has been recorded within 30 km, *Quoya zonalis* (formerly *Pityrodia* sp. Marble Bar, listed as Endangered under the EPBC Act and BC Act). One P1, twelve P3, and two P4 species have records within 30 km of the Survey Area.

No additional T species were returned from the PMST. The literature review included a local record of *Rothia indica* subsp. *australis* (APM 2022a), which increased the likelihood of occurrence from Possible to Likely.

T and P flora returned from the DBCA database search with records within 30 km of the Survey Area are shown in Figure 4-1.



Author: EH Approved: ML Date: 02/01/2024

Threatened and Priority Flora database records

Prepared for:
4-1
 Scale: @ A4
 1: 30,000
 Coordinate System: GDA 2020 MGA Zone 50
 Projection: Transverse Mercator

Legend

- Threatened**
 ★ *Quoya zonalis*
- Priority 1**
 ▲ *Acacia leeuweniana*

Priority 3

- *Eragrostis crateriformis*
- *Euphorbia clementii*
- *Euploca mutica*
- *Gomphrena leptophylla*
- *Gymnanthera cunninghamii*
- *Nicotiana umbratica*
- *Phyllanthus hebecarpus*
- *Rothia indica* subsp. *australis*
- *Stylidium weeliwolli*

Priority 4

- *Terminalia supranitifolia*
- *Triodia chichesterensis*
- *Vigna triodiophila*
- ✚ *Bulbostylis burbridgeae*
- ✚ *Goodenia nuda*

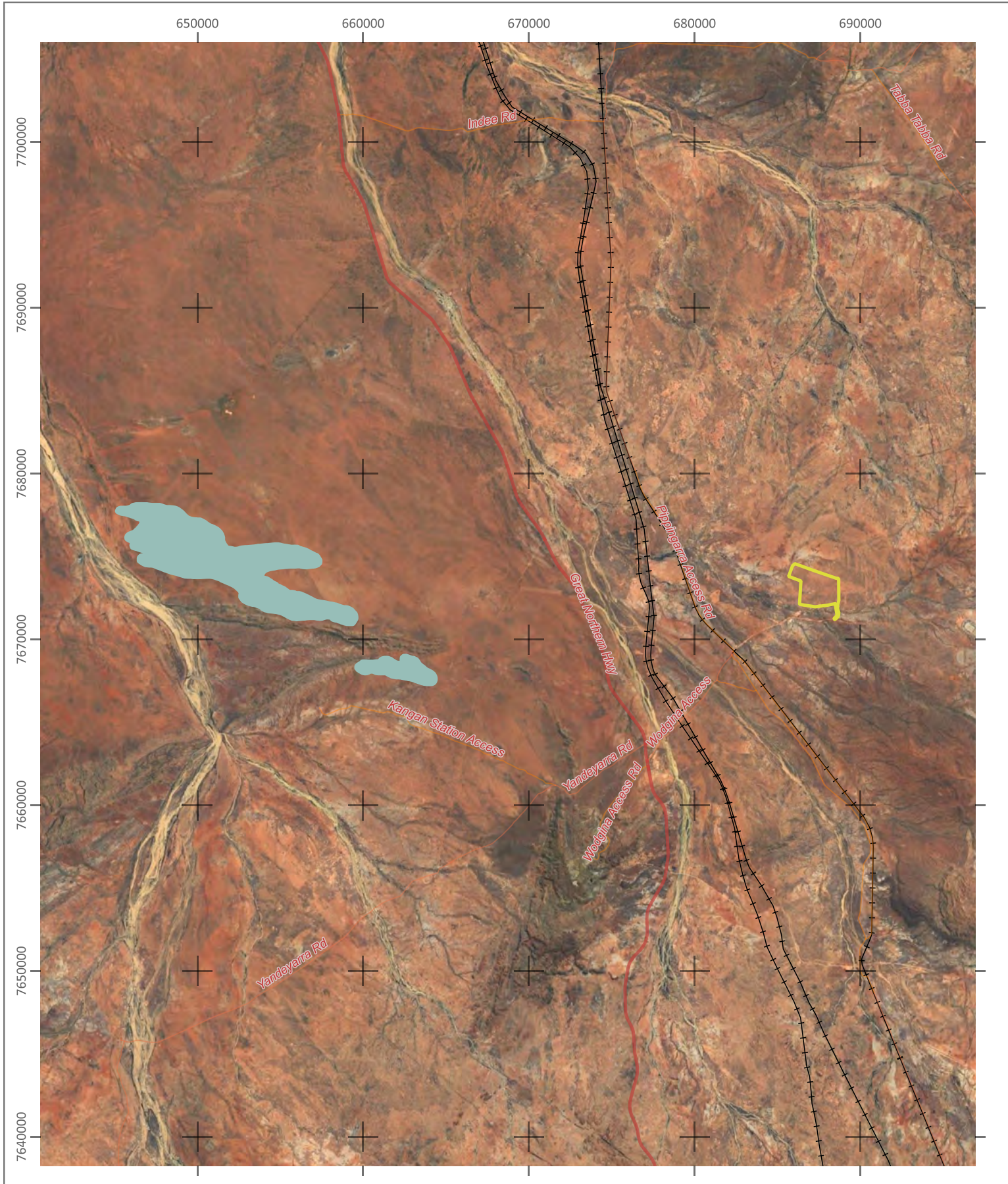
An assessment of the likelihood of occurrence of these 16 species within the Survey Area was performed using the criteria listed in Table 3-2. The results of the assessment are listed in Table 4-1.

Table 4-1. Threatened and Priority Flora Likelihood of Occurrence

Species	Cons. Code		Preferred Habitat	Likelihood of Occurrence
	BC Act	EPBC Act		
<i>Acacia leeuweniana</i>	P1	-	Gritty, skeletal red-grey sandy loam, light orange-brown gravelly sand, granite. In rock fissures in outcrops, among boulders.	Possible. Granite domes in sandy plains but lacking fissures and boulders.
<i>Bulbostylis burbridgeae</i>	P4	-	Granitic soils. Granite outcrops and cliff bases.	Possible. Granite domes in sandy plains but lacking soil buildup in crevices and no cliff bases present.
<i>Eragrostis crateriformis</i>	P3	-	Clayey loam or clay. Creek banks, depressions.	Unlikely. Clay rich soils absent.
<i>Euphorbia clementii</i>	P3	-	Gravelly hillsides, stony grounds.	Unlikely. No suitable habitat.
<i>Euploca mutica</i>	P3	-	Hummock grassland and sandplains.	Present. Suitable habitat in Undulating Plains.
<i>Gomphrena leptophylla</i>	P3	-	Open flats, sandy creek beds, edges salt pans and marshes, stony hillsides.	Possible. Suitable habitat in the plains and sandy creek beds.
<i>Goodenia nuda</i>	P4	-	Has been previously found in drainage lines of red-brown loamy sand or sandy loam and in disturbed roadside areas.	Likely. Suitable habitat in creeks.
<i>Gymnanthera cunninghamii</i>	P3	-	Sandy soils, creeks.	Likely. Suitable habitat in sandy creeks.
<i>Nicotiana umbratica</i>	P3	-	Typically grows in shelter of large boulders on rocky outcrops and in shallow soils.	Unlikely. No boulder development in granite outcrop areas.
<i>Phyllanthus hebecarpus</i>	P3	-	Granite boulders/outcropping.	Unlikely. No boulder development in granite outcrop areas.
<i>Quoya zonalis</i>	EN	EN	Steep, rocky, sandstone conglomerate and granite slopes in skeletal, brown, sandy loam soils of the Capricorn Land System.	Unlikely to occur. No suitable habitat.
<i>Rothia indica</i> subsp. <i>australis</i>	P3	-	Sandy soils. Seasonally inundated areas, sandhills and flats.	Likely. Suitable habitat in Undulating Plains.
<i>Stylidium weeliwolli</i>	P3	-	Gritty sand soil, sandy clay. Edge of watercourses.	Possible. Sandy creek edges.
<i>Terminalia supranitifolia</i>	P3	-	Sand. Among basalt rocks.	Unlikely to occur.
<i>Triodia chichesterensis</i>	P3	-	Occurs on sand or loam over rocky or gravelly substrates, often with quartzite.	Present. Suitable habitat includes low rises with rocky soils containing quartzite.
<i>Vigna triodiophila</i>	P3	-	Local record among dolerite boulders on very steep upper slope. Stony red-brown clay loam.	Unlikely to occur.

4.1.2 Significant Vegetation

There are no TECs listed under the BC Act or EPBC Act known to occur within the Survey Area. One P3 Ecological Community is located approximately 23 km west of the Survey Area; the Gregory Land System (Figure 4-2).



Author: EH Approved: ML Date: 02/01/2024

Threatened and Priority Ecological Communities

- Legend**
- Gregory Land System Priority 3 Ecological Community
 - Survey Area



Prepared for:
Pilbara Minerals
4-2

Scale: @ A4
 1: 30,000

Coordinate System: GDA 2020 MGA Zone 50
 Projection: Transverse Mercator

4.1.3 Introduced Flora Species

Dandjoo returned two introduced flora species, *Cenchrus ciliaris* and *Flaveria trinervia*, both categorised as S11-Permitted under the BAM Act. Eleven introduced flora species have been recorded locally by previous surveys (MMWC Environmental 2016a; APM 2022a,b), including two Declared pests also listed as WONS.

Table 4-2 lists the introduced flora species recorded within 30 km of the Survey Area.

Table 4-2. Introduced Flora Records within 30 km of the Survey Area

Species	Common Name	BAM Act Listing	WONS
<i>Aerva javanica</i>	Kapok Bush	Permitted – S11	No
<i>Cenchrus ciliaris</i>	Buffel Grass	Permitted – S11	No
<i>Cenchrus setiger</i>	Birdwood Grass	Permitted – S11	No
<i>Chloris barbata</i>	Purpletop Chloris	Permitted – S11	No
<i>Cynodon dactylon</i>	Couch Grass	Permitted – S11	No
<i>Flaveria trinervia</i>	Speedy Weed	Permitted – S11	No
<i>Malvastrum americanum</i>	Spiked malvastrum	Permitted – S11	No
<i>Opuntia stricta</i>	Common Prickly Pear	Declared Pest – S11(2) (C3 Restricted)	Yes
<i>Passiflora foetida</i> var. <i>hispida</i>	Stinking Passion Flower	Permitted – S11	No
<i>Tamarix aphylla</i>	Athel Pine	Declared Pest – S22(2) (Exempt)	Yes
<i>Triumfetta pentandra</i>	-	Permitted – S11	No

4.2 FIELD SURVEY

4.2.1 Flora

A total of 61 species of flora were recorded within the Survey Area, comprising 59 native species and two introduced species. All specimens were identified to species level.

The *Fabaceae* (pea family, 18 native species), *Poaceae* (grass family, 15 native species, two introduced) and *Amaranthaceae* (five native species) were the most species-rich families recorded. Fifteen families represented by 37 genera were recorded across the Survey Area.

The complete list of plant species recorded within the Survey Area is presented in Appendix F. The mean species richness was 15.3 species per quadrat. This is lower than other local surveys including the MMWC Environmental (2016a) Pilgangoora baseline survey which included 49 detailed sites with an average species richness of 25, the Infill Biological Survey (APM 2023b) with 17 detailed sites and an average richness of 32, TSF Option 2 and 5 Survey (APM 2022b) with 19 detailed sites and an average species richness of 23, and the Lynas Find Survey (APM 2022a) with 23 detailed sites and an average

species richness of 20. The low species richness is likely a consequence of survey season and seasonal conditions.

A species accumulation curve (Appendix F) was performed, returning a modelled Michaelis-Menton species richness of 90, indicating that the floristic survey was approximately 68% complete.

The survey recorded ten species not previously encountered at the Pilgangoora Project. These species are identified in Appendix F and bring the total richness for the Pilgangoora Project area to 298 including subspecies, and varieties.

Floristic groups identified in the cluster analysis were organised into vegetation types and are discussed in the following section. The cluster analysis grouped sites into two major divisions, one occurring across the undulating sandy plains, which occupy the majority of the site, and the other grouping sites occurring in drainage features.

Significant flora are detailed in Section 4.2.4 and introduced flora species are detailed in Section 4.2.6.

4.2.2 Vegetation Types

Three vegetation types are described for the Survey Area, as summarised in Table 4-3 and detailed below.

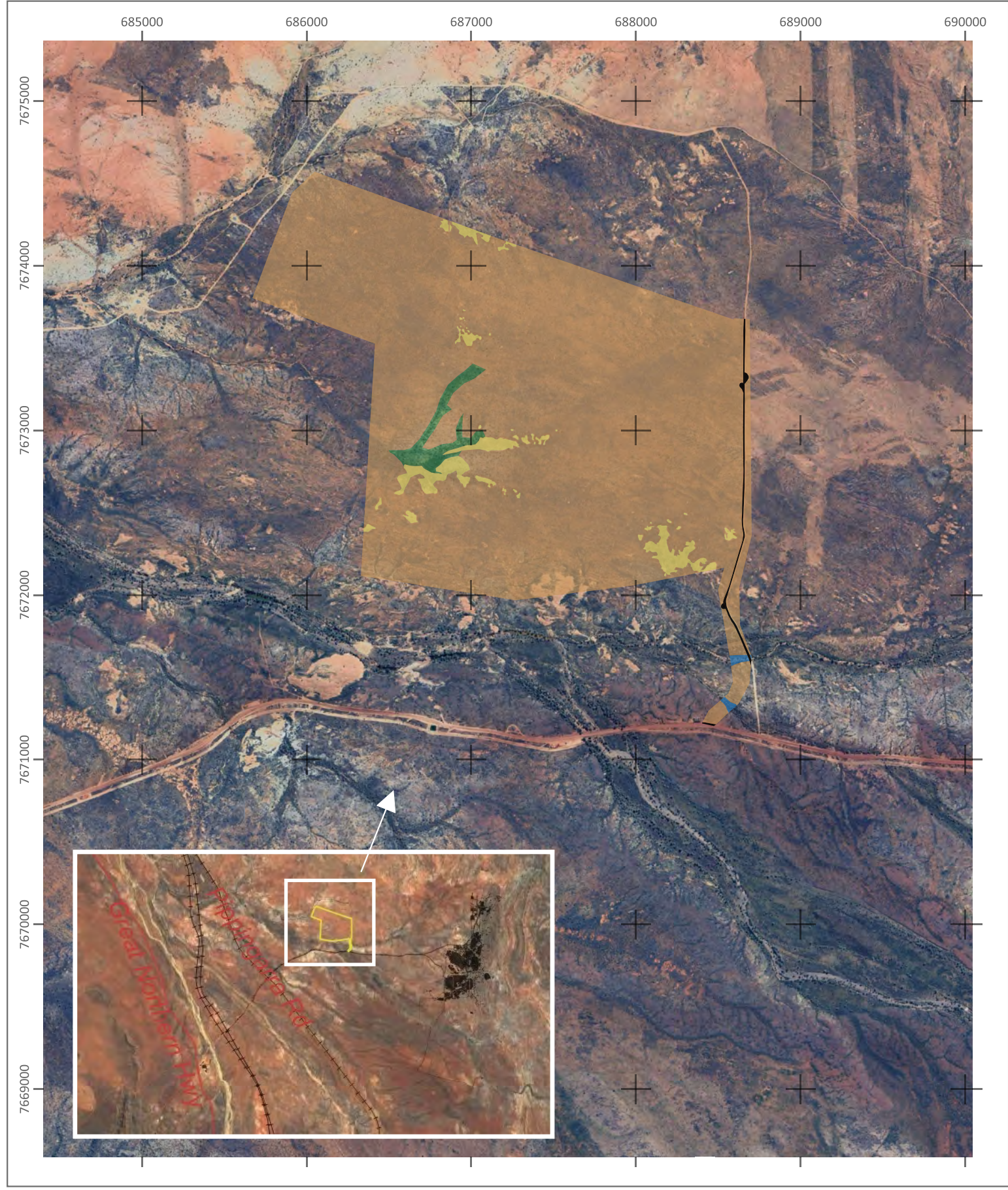
Table 4-3. Vegetation Types

Code	Landform	Vegetation Description	ha	%
4b	Sandy Creek	Low open woodland of <i>Eucalyptus victrix</i> over <i>Acacia bivenosa</i> , <i>Acacia trachycarpa</i> and <i>Acacia stellaticeps</i> tall open shrubland with <i>Triodia epactia</i> , <i>Triodia wiseana</i> and <i>Triodia secunda</i> hummock grassland.	0.95	0.2
7b	Drainage Depression	Low open woodland of <i>Corymbia hamersleyana</i> over <i>Acacia bivenosa</i> , <i>Acacia acredenia</i> and <i>Acacia inaequilatera</i> tall sparse shrubland with <i>Triodia wiseana</i> , <i>Triodia epactia</i> and <i>Triodia secunda</i> hummock grassland.	8.90	1.7
12a	Undulating plains	Isolated low <i>Corymbia hamersleyana</i> and <i>Corymbia zygomphylla</i> over <i>Acacia stellaticeps</i> , <i>Acacia inaequilatera</i> and <i>Acacia adsurgens</i> sparse mid shrubland with mid hummock grassland of <i>Triodia lanigera</i> , <i>Triodia wiseana</i> and <i>Triodia epactia</i> .	493.16	94.6
16b	Sandy basin	Hummock grassland of <i>Triodia secunda</i> and <i>Triodia epactia</i> with open herbfield of <i>Pluchea tetranthera</i> , <i>Fimbristylis dichotoma</i> and <i>Eriachne ciliata</i> .	15.93	3.1
D	-	Disturbed – clear of vegetation	2.45	0.5

Vegetation types are described below and are compared to those previously recorded for the Pilbara Minerals Pilgangoora Project using structural comparison and common species assemblages. Where communities share a high level of similarity, the vegetation code previously applied has been used here and a discussion of similarity presented. The cluster analysis (Appendix C) grouped the sites occurring in drainage features. They have been described below as separate vegetation types to better reflect the differences in habitat availability and the previously described vegetation types across the Pilgangoora Project.

The DBCA fire history database indicates that approximately 80% of the Survey Area was burned in 2014, and the north western corner (approximately 20%) is long unburned. On-ground observations supported these remotely recorded fire records. Post fire-regeneration has occurred in all areas and time since fire was considered in the assessment of vegetation condition.

Distribution of vegetation types at a scale of 1: 20,000 is shown in Figure 4-3. The dendrogram resulting from the cluster analysis is shown in Appendix C, followed by the site data sheets and photos.




Author: EH Approved: ML Date: 02/01/2024

Vegetation Types

- Legend**
- 4b Sandy creek
 - 7b Drainage depression
 - 12a Undulating plains
 - 16b Sandy basin
 - Disturbed




Prepared for:




4-3

Scale: @ A4
1: 30,000



Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



Landform: Sandy creek

Vegetation Type: 4b

Low open woodland of *Eucalyptus victrix* over *Acacia bivenosa*, *Acacia trachycarpa* and *Acacia stellaticeps* tall open shrubland with *Triodia epactia*, *Triodia wiseana* and *Triodia secunda* hummock grassland.

This vegetation type is within Pilgangoora creek, a tributary of Chinnamon Creek, 1.6 km upstream of the confluence. It is an ephemeral creek with no permanent or semi-permanent pools, which appear to be more common in Chinnamon Creek below the confluence.

The overstorey is composed of an open canopy of medium to large trees. The shrub layer is tall and dense on the riparian banks compared to the surrounding plains. Shrub species also included *Cajanus cinereus*, *Indigofera monophylla*, *Corchorus incanus*, *Senna notabilis* and *Hibiscus austrinus*. Groundcover is relatively diverse and also included *Heteropogon contortus*, *Themeda triandra*, **Cenchrus setiger*, **Cenchrus ciliaris*, *Dichanthium fecundum*, *Triodia wiseana*, *Rhynchosia minima*, *Chrysopogon fallax*, *Alternanthera nana*, *Bonamia erecta*, *Cyperus vaginatus*, *Euphorbia careyi*, *Goodenia microptera*, *Eragrostis elongata*, *Sorghum plumosum* and *Sporobolus australasicus*.

This vegetation type has previously been recorded at the Pilgangoora Project and allocated the code 4b.



Plate 4-1. Sandy creek

Condition: Impacts from cattle grazing are major with palatable understory species heavily grazed and other fringing vegetation trampled, the agricultural weeds *Cenchrus ciliaris* and *Cenchrus setiger* are present and occasional tracks are present. The condition of this vegetation is Good.

Detailed sites: P6 Total richness: 28 species.

Introduced/exotic taxa: *Cenchrus ciliaris* and *Cenchrus setiger*

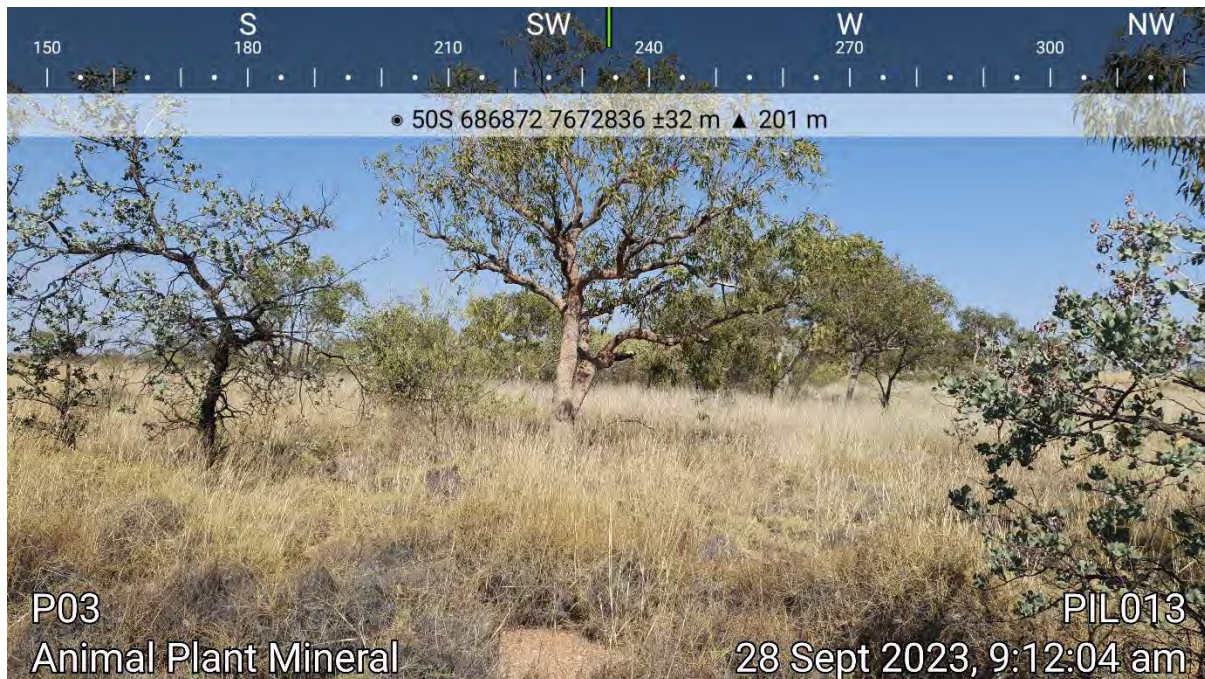
Conservation significant species: none recorded

Landform: Drainage depression**Vegetation Type: 7b**

Low open woodland of *Corymbia hamersleyana* over *Acacia bivenosa*, *Acacia achedenia* and *Acacia inaequilatera* tall sparse shrubland with *Triodia wiseana*, *Triodia epactia* and *Triodia secunda* hummock grassland.

The tree and shrub cover are taller and denser than surrounding plains vegetation as the area receives run-on, which eventually becomes a narrow creek to the west of the Survey Area. Additional shrub species recorded include *Cajanus cinereus*, *Indigofera monophylla*, *Indigofera rugosa*, *Senna glutinosa* and *Corchorus incanus*. Additional groundcover species include *Pluchea tetranthera*, *Cenchrus setiger*, *Indigofera hirsuta*, *Rhynchosia minima*, *Cassutha filiformis*, *Trigastrotheca molluginea* and *Chrysopogon fallax*.

This vegetation type was grouped with P6 and P10 in the cluster analysis (Appendix C), as they are all water gaining areas. In comparison to vegetation types previously mapped across the broader Pilgangoora project, this vegetation type best fits with the Drainage depression vegetation type 7b and has been allocated that name here.

**Plate 4-2. Drainage depression**

Condition: Impacts from cattle grazing are light and the agricultural weed *Cenchrus setiger* is present. The condition of this vegetation is Very Good.

Detailed sites: P3 Total richness: 19 species.

Introduced/exotic taxa: *Cenchrus setiger*

Conservation significant species: none recorded

Landform: Undulating plains**Vegetation Type: 12a**

Isolated low *Corymbia hamersleyana* and *Corymbia zygophylla* over *Acacia stellaticeps*, *Acacia inaequilatera* and *Acacia adsurgens* sparse mid shrubland with mid hummock grassland of *Triodia lanigera*, *Triodia wiseana* and *Triodia epactia*.

The tree layer is sparse and is limited to low individual trees to 4 m tall. The mid shrub layer is dominated by *Acacia*, primarily *Acacia stellaticeps*, *Acacia inaequilatera* and *Acacia adsurgens*. Other common shrub species including *Acacia maitlandii*, *Grevillea pyramidalis*, *Senna glutinosa*, *Grevillea wickhamii*, *Indigofera monophylla*, *Acacia acradenia*, *Acacia orthocarpa*, *Crotalaria dissitiflora*, *Cajanus cinereus* and *Hakea lorea* subsp. *lorea* and *Senna artemisioides* are also present.

Groundcover was dominated by *Triodia* hummock grasses. Additional groundcover species recorded included *Bonamia erecta*, *Cassytha filiformis*, *Ptilotus astrolasius*, *Euploca mutica* (P3), *Corchorus incanus*, *Trigastrotheca molluginea*, *Gomphrena leptoclada*, *Ptilotus calostachyus*, *Pluchea dentex*, *Pterocaulon sphacelatum*, *Cucumis argenteus*, *Fimbristylis dichotoma*, *Euphorbia careyi*, *Chrysopogon fallax*, *Eriachne ciliata*, *Fimbristylis dichotoma* and *Paspalidium clementii*.

This is the most commonly occurring vegetation type in the Survey Area and occurs on sandy soils on undulating plains, with or without gravel at the surface. This vegetation type has been recorded commonly in the sandy plains across the broader Pilgangoora project, as vegetation type 12a.

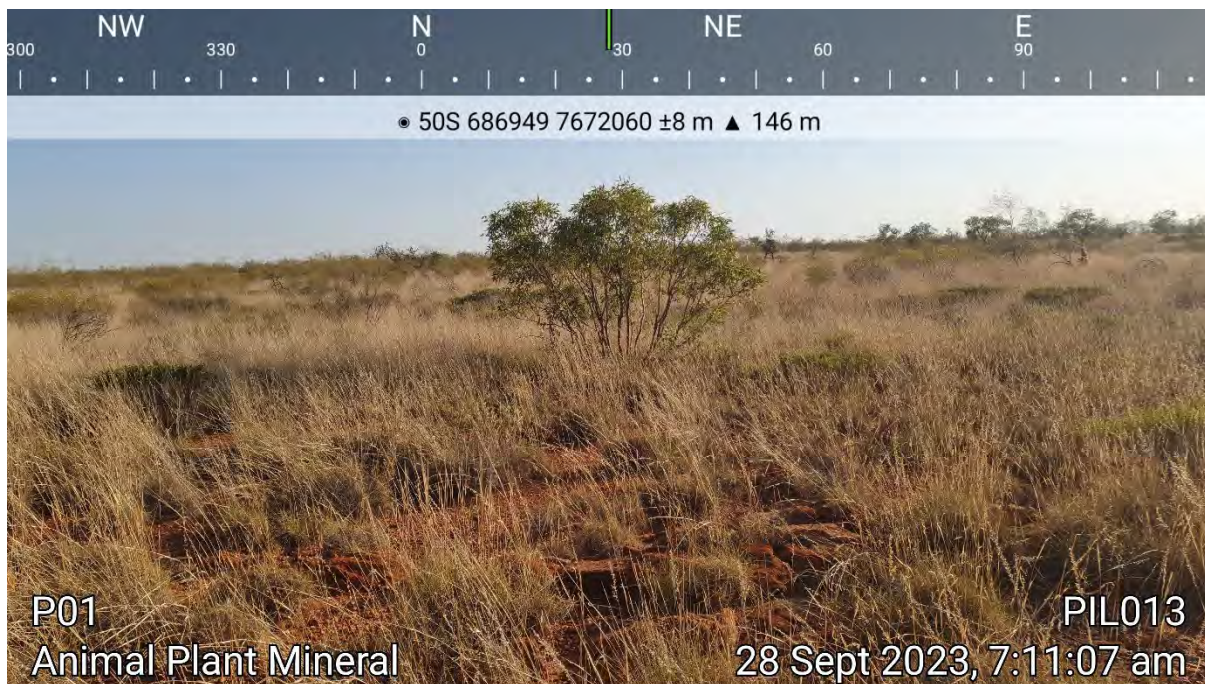


Plate 4-3. Undulating plains

Condition: Impacts from cattle grazing are minor, and occasional tracks are present. The condition of this vegetation is Very Good.

Detailed sites: P1, P2, P4, P5, P7, P8 and P9. Total richness: 39 species. Average richness: 13.1 species.

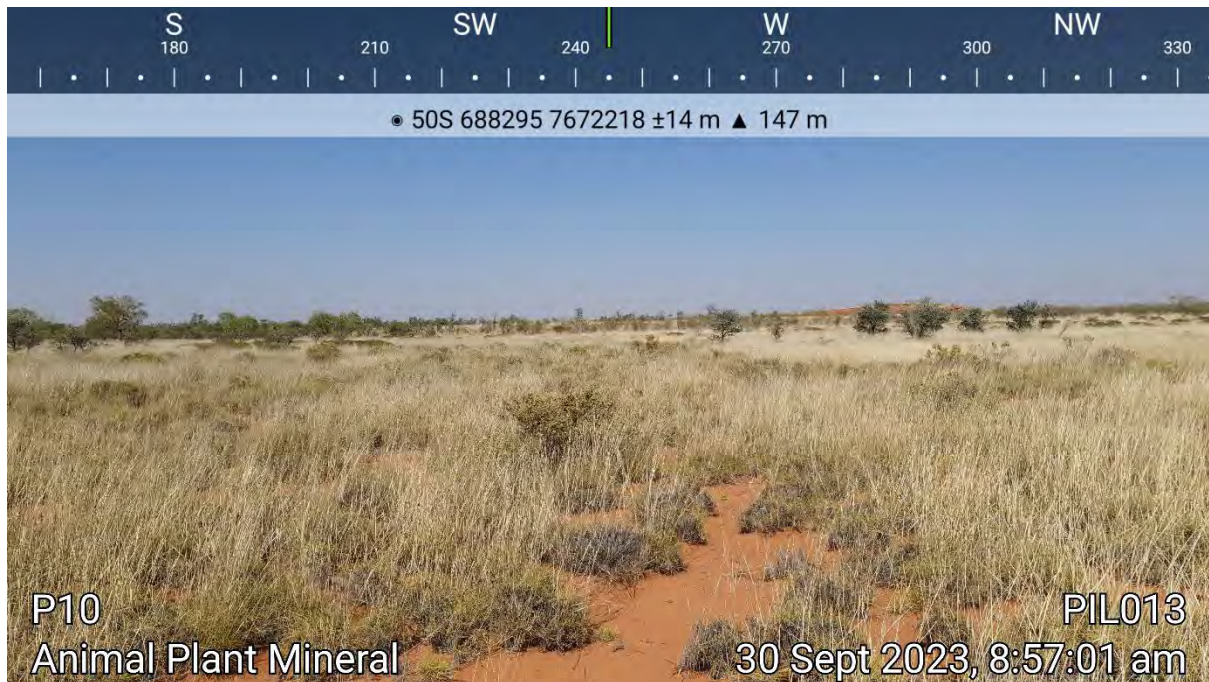
Introduced/exotic taxa: none recorded. Conservation significant species: *Euploca mutica* (P3) was recorded at 2 sites (P05 and P08) at 0.1% cover.

Landform: Sandy basin**Vegetation Type: 16b**

Hummock grassland of *Triodia secunda* and *Triodia epactia* with open herbfield of *Pluchea tetranthera*, *Fimbristylis dichotoma* and *Eriachne ciliata*.

This vegetation type is lacking an overstorey layer and the shrub layer is absent except a scattering of *Acacia inaequilatera* and *Acacia stellaticeps* on the margins or in elevated islands. The vegetation type occurs on deep sandy basins of lower elevation than the surrounding plains and is relatively depauperate of species. *Sporobolus actinocladus* was sparsely present, and *Triodia wiseana* occurred in small abundance on the fringes.

This vegetation type has not previously been described for the Pilgangoora Project.

**Plate 4-4. Sandy basin**

Condition: Impacts from cattle grazing are very low, no weeds are present and occasional tracks are present. The condition of this vegetation is Very Good.

Detailed sites: P10

Total richness: 9 species.

Introduced/exotic taxa: none

Conservation significant species: none

4.2.3 Vegetation Condition

Vegetation condition across the Survey Area was within the categories Very Good, Good and Completely Degraded, with most of the Survey Area in Very Good condition (Table 4-4; Figure 4-4).

Table 4-4. Vegetation condition within the Survey Area

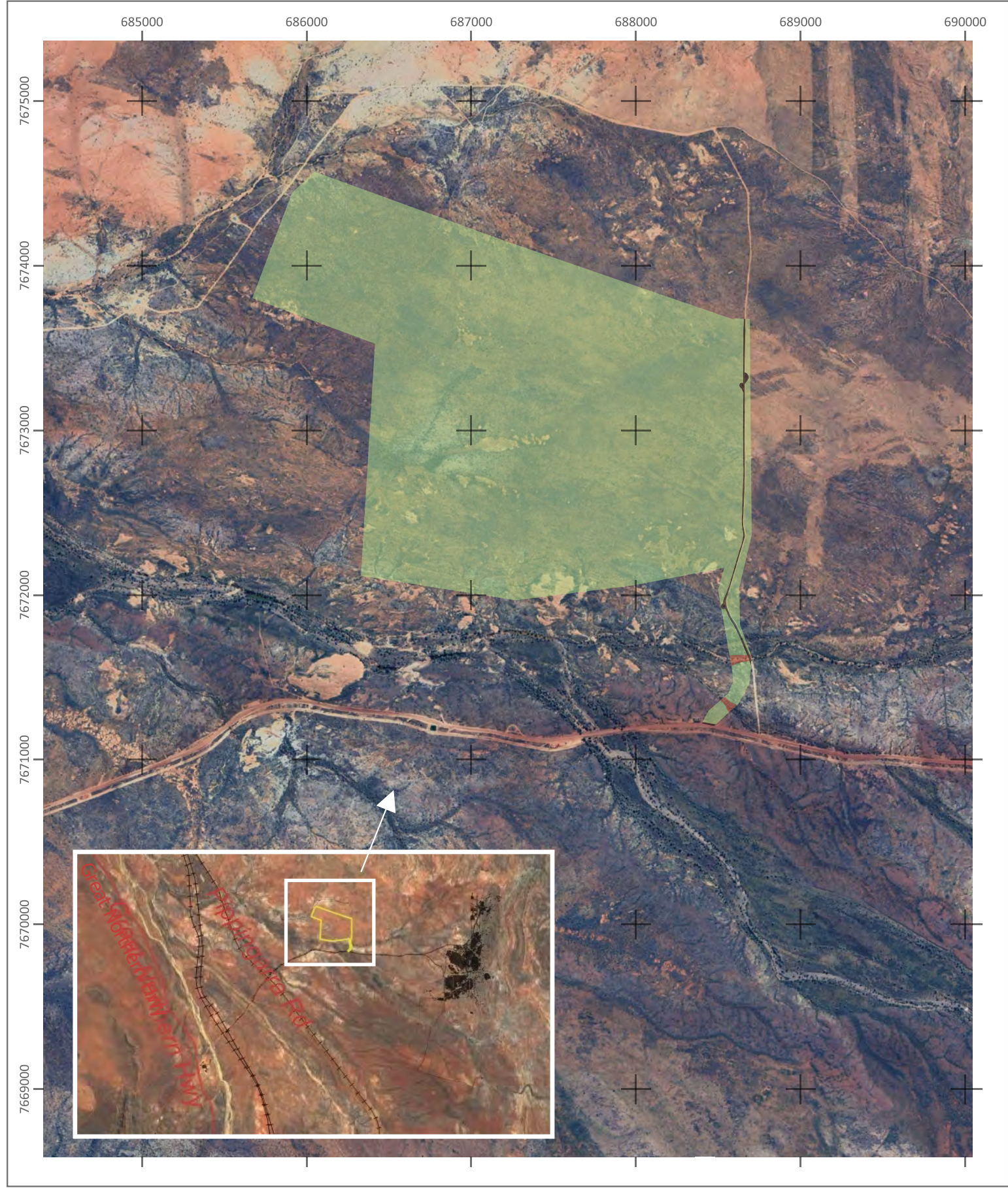
Vegetation Condition	Area (ha)	Area (%)
Very Good	517.91	99.3
Good	0.95	0.2
Completely Degraded	2.45	0.5

The primary sources of disturbance on-site are low to moderate grazing impact from cattle and occasional tracks that support pastoralism activities. Additional tracks are present in support of the nearby mining and exploration activities.

Areas receiving a condition rating of Very Good had a low level of grazing activity and occasional tracks may be present.

Areas receiving a condition rating of Good had weeds present, a moderate level of grazing activity and occasional vehicle tracks. This was limited to the sandy creek areas in the southern extent of the Survey Area.

Areas classified as Completely Degraded are cleared of vegetation and maintained in a vegetation free state. This was limited to an existing track on the eastern side of the Survey Area.




Author: EH Approved: ML Date: 02/01/2024

Vegetation Condition

- Legend**
- Very Good
 - Completely Degraded
 - Good




Prepared for:




4-4

Scale: @ A4 1: 30,000



Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



4.2.4 Significant Flora

No species listed as T under the EPBC Act or BC Act were recorded during the survey.

Two P3 species *Triodia chichesterensis* and *Euploca mutica* were recorded during the survey.

4.2.4.1 *Triodia chichesterensis*

Triodia chichesterensis is described by Anderson *et al.* (2017). It is characterised by being a short-leaved species, distinguished by the combination of diminutive stature, glabrous leaf sheaths, relatively unbranched inflorescence, often short pedicels, and pubescent lemma midlobe. The short pedicels and pubescent lemma midlobe contrast with the typically longer pedicels and glabrous lemma midlobes of other short-leaved species in the complex (*T. nana*, *T. scintillans*, *T. vanleeuwenii*).

The species has a limited distribution and has been found only in a narrow area in the central Chichester region of the Pilbara of WA. The areas immediately to the west and east of its known distribution are poorly explored, but it is likely to be restricted to an area <100 km beyond current collections, given intensive collecting efforts in the Pilbara (Anderson *et al.* 2017).

The Survey Area is in the central part of the range of this species, which is significant from the perspective of determining it from the closely related *Triodia lanigera* (Anderson *et al.* 2017). Where the two co-occur in the south it can be difficult to determine them based on morphological and distributional parameters. Where the two co-occur in the north, there is a subtle but consistent substrate change that marks the shift in species, with *T. lanigera* occurring on sandier soils and *T. chichesterensis* on rockier soils with quartzite pieces. In the northern species range, it can usually be morphologically distinguished from *T. lanigera* by its shorter and less hairy leaves and less branched inflorescences.

The species has been previously recorded from studies conducted for the Pilgangoora Project and appears to be locally common on rocky soils with quartzite (APM, 2022a,b, APM, 2023). The species was recorded at one location in the northwestern corner of the Survey Area as shown in Figure 4-5, within sandy red soils where a patch of quartzite was present. This habitat extended further to the west outside of the Survey Area.

4.2.4.2 *Euploca mutica*

Euploca mutica is a small, perennial herb/shrub that grows to approximately 0.3 m. Collection records for the species (Atlas of Living Australia [ALA] 2023) identify that flowering specimens are often collected in August, and that habitat includes sandy or calcareous plains, often on granite geology, with a sandy or loamy surface often with ironstone and quartz.

The species was first recorded in the local area during surveys undertaken by MMWC Environmental in 2016a. At the time of the MMWC Environmental (2016) survey the species was known as *Heliotropium muticum* and was considered to be a Priority 1 species. Taxonomic revision for the species has led to the revision of the name to *Euploca mutica* (Frohlich *et al.* 2020) and targeted searches resulting in increased known population size has led to a revision of the status to Priority 3.

The species has previously been recorded at six locations during studies conducted for the Pilgangoora Project (MMWC Environmental 2016, APM (2023b)). In the P1000 survey it was recorded at two locations,

P05 and P08. These quadrats are in sandplain habitat, known to be potentially suitable habitat for the species. The species was recorded at low densities in both locations at 0.1% cover. In a simultaneous study 11.5 km to the southwest (APM, in prep) the species was recorded in two locations. In the Pilgangoora area the species appears to be sporadically distributed in low densities, as expected from local database records.



Author: EH Approved: ML Date: 02/01/2024

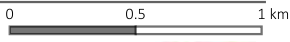
Priority flora records

Prepared for:



4-5

Scale: @ A4
1: 30,000



Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



Legend

- Euploca mutica (P3)
- Triodia chichesterensis (P3)
- P1000 Survey Area



4.2.5 Significant Vegetation

No vegetation types occurring within the Survey Area are analogous to any known TEC's or PEC's.

One species associated with Groundwater Dependent Ecosystems was recorded. *Eucalyptus victrix* was recorded in vegetation type 4b in the Sandy Creek. Individuals were scattered in distribution but were mature, with a diameter at breast height less than 30 cm. *Eucalyptus victrix* is regarded as being a facultative phreatophyte that most likely draws most of its water requirement from the unsaturated zone but can use groundwater opportunistically if groundwater is available at or less than 10 m below ground level (Pfautsch *et al.* 2014).

4.2.6 Introduced Flora

Two introduced flora species were recorded in the Survey Area and are listed in Table 4-5. No Declared Weeds or WONS were recorded.

Table 4-5. Introduced Flora Recorded within the Survey Area

Species	Common name	Description
		BAM Act S11 - Permitted
<i>Cenchrus ciliaris</i>	Buffel grass	Tufted or sometimes stoloniferous perennial, grass-like or herb. 0.2 - 1.5 m high. Flowers purple from February to October. Grows on white, red, or brown sand, stony red loam, or black cracking clay.
<i>Cenchrus setiger</i>	Birdwood Grass	Erect, tussocky, stoloniferous perennial, herb or grass-like, to 0.5 m high. Flowers cream to purple from April to May. Grown in brown sands, red loam and pindan soils on sand dunes, plains, rangelands, stony hillsides or floodplains.

The agricultural weeds *Cenchrus ciliaris* and *Cenchrus setiger* was recorded in drainage lines, occurring only occasionally and in generally low abundance. Where found, these weeds were heavily grazed.

5 TERRESTRIAL VERTEBRATE FAUNA RESULTS

5.1 DESKTOP STUDY

5.1.1 Significant Fauna

The DBCA database returned 16 species of significant fauna that have previously been recorded within 30 km of the Survey Area. Of these, six are T, six are P, three are migratory bird species (**MI**) and one is Other Specifically Protected (**OS**). Record locations of significant fauna in relation to the Survey Area are shown in Figure 5-1. The database does not contain any records for fauna within the Survey Area.

The PMST returned 12 additional species, five T, six MI and one that is both T and MI. These are species that do not have records within 30 km but where modelling has identified that suitable habitat is known to occur or may occur.

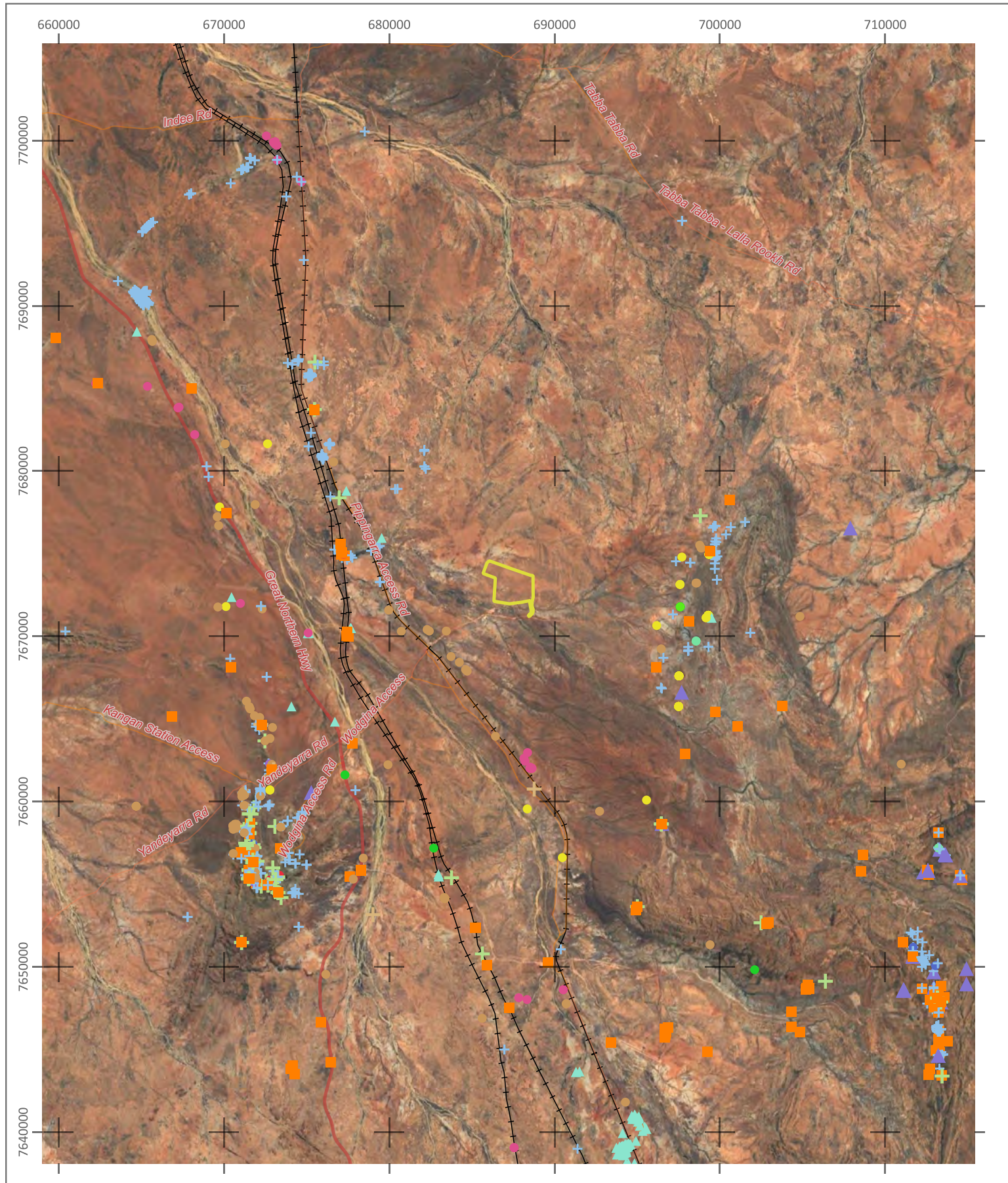
The literature review returned additional information about the locations and abundance of Northern Quoll, Pilbara leaf-nosed Bat, Ghost Bat, Pilbara Olive Python and Pebble-mound Mouse records.

Database search results of T, P and MI fauna within 30 km of the Survey Area are listed in Table 5-1, with the outcome of the likelihood of occurrence assessment. The complete assessment including the preferred habitat relative to those available in the Survey Area and a summary of records in the local area is included in Appendix G.

5.1.2 Introduced Fauna

Dandjoo database records did not return any introduced fauna. A search of the superseded NatureMap database in September 2022 for a nearby area returned records for eight introduced fauna as listed below:

- Camel (*Camelus dromedarius*);
- Cat (*Felis catus*);
- Cattle (*Bos taurus*);
- Dog (*Canis lupus*);
- Donkey (*Equus asinus*)
- Fox (*Vulpes vulpes*)
- Horse (*Equus caballus*); and
- House mouse (*Mus musculus*).



Author: EH Approved: ML Date: 05/01/2024

Significant Fauna Records

Prepared for:
5-1
 Scale: @ A4
 1: 300,000
 Coordinate System: GDA 2020 MGA Zone 50
 Projection: Transverse Mercator

Legend

Threatened

- + *Dasyurus hallucatus* (EN)
- + *Falco hypoleucos* (VU)
- ▲ *Liasis olivaceus barroni* (VU)
- + *Macroderma gigas* (VU)
- ▲ *Macrotis lagotis* (VU)
- *Rhinonictes aurantia* (Pilbara) (VU)

Priority

- *Anilius ganei* (P1)
- *Dasycercus blythi* (P4)
- *Hipposideros stenotis* (P2)
- *Lagorchestes conspicillatus leichardti* (P4)
- *Pseudomys chapmani* (P4)
- *Sminthopsis longicaudata* (P4)

Migratory and Other

- *Actitis hypoleucos* (MI)
- *Apus pacificus* (MI)
- *Charadrius veredus* (MI)
- *Falco peregrinus* (OS)

Table 5-1. Significant fauna database records and likelihood of occurrence

Species	Common Name	Conservation Code		Assessment of Occurrence
		BC Act	EPBC Act	
<i>Actitis hypoleucos</i>	Common sandpiper	MI	MI	
<i>Calidris acuminata</i>	Sharp-tailed sandpiper	MI	MI	
<i>Calidris ferruginea</i>	Curlew sandpiper	CR	CR, MI	
<i>Calidris melanotos</i>	Pectoral sandpiper	-	MI	Unlikely. No saline or coastal habitats available.
<i>Numenius madagascariensis</i>	Eastern curlew	CR	CR, MI	Freshwater habitats are likely to be seasonally present in the major drainage line however there are no permanent or semi-permanent pools evident. Substrates are sandy, meaning infiltration is likely to be rapid and surface water very limited. No vegetation known to inhabit seasonally inundated environments was recorded.
<i>Glareola maldivarum</i>	Oriental pranticole	MI	MI	
<i>Hirundo rustica</i>	Barn swallow	MI	MI	
<i>Motacilla cinerea</i>	Grey wagtail	MI	MI	
<i>Motacilla flava</i>	Yellow wagtail	MI	MI	
<i>Apus pacificus</i>	Fork-tailed swift	MI	MI	Possible. Utilises a broad array of habitats.
<i>Charadrius veredus</i>	Oriental plover	MI	MI	Likely. Suitable habitat in the open plains.
<i>Polytelis alexandrae</i>	Princess parrot	-	VU	Unlikely, preferred feeding species are not present in high densities along the major drainage.
<i>Erythrotriorchis radiatus</i>	Red goshawk	VU	VU	Unlikely. Not within the known range of the species distribution.
<i>Falco hypoleucos</i>	Grey falcon	VU	VU	Likely. All areas are suitable for foraging. No suitable nesting habitat.
<i>Falco peregrinus</i>	Peregrine falcon	OS	-	Possible. All areas are suitable for foraging. No suitable nesting habitat.

Species	Common Name	Conservation Code		Assessment of Occurrence
		BC Act	EPBC Act	
<i>Pezoporus occidentalis</i>	Night parrot	CR	EN	Possible. No local records. Habitat modelling includes the Survey Area at the extremity of the species potential extent. Foraging resources are limited.
<i>Rostratula australis</i>	Australian painted-snipe	EN	EN	Unlikely. No habitat occurs in the Survey Area. Vegetation too open to provide well vegetated shallows.
<i>Dasyercus blythi</i>	Brush-tailed mulgara	P4	-	Present. Sandy basin habitat is suitable.
<i>Dasyurus hallucatus</i>	Northern quoll	EN	EN	Likely. Dispersal and foraging habitat, denning habitat in the granite overhangs and tree hollows in the creek vegetation.
<i>Hipposideros stenotis</i>	Northern leaf-nosed bat	P2		Unlikely. No suitable habitat. Nearby records may be erroneous.
<i>Lagorchestes conspicillatus leichardti</i>	Spectacled hare-wallaby	P4	-	Likely. Suitable habitat is present in the Spinifex Open Plains habitat.
<i>Macroderma gigas</i>	Ghost bat	VU	VU	Likely. Foraging habitat available. No roosting habitat available.
<i>Macrotis lagotis</i>	Greater bilby	VU	VU	Possible. All habitats are suitable.
<i>Pseudomys chapmani</i>	Western pebble-mound mouse	P4	-	Unlikely. No suitable habitat. Stony rises absent.
<i>Rhinonictoris aurantia</i>	Pilbara leaf-nosed bat	VU	VU	Likely. No roosting habitat available, foraging habitats present.
<i>Sminthopsis longicaudata</i>	Long-tailed dunnart	P4	-	Unlikely. No suitable habitat.
<i>Anilius ganei</i>	Gane's blind snake (Pilbara)	P1	-	Unlikely. No suitable habitat.
<i>Liasis olivaceus</i> subsp. <i>baronni</i>	Pilbara olive python	VU	VU	Present. Recorded on camera using a termite mound.
<i>Liopholis kintorei</i>	Great desert skink	VU	VU	Unlikely. No records in the local area. May occur 10 km to the east.

5.2 FIELD SURVEY

5.2.1 Fauna Habitats

The Survey Area is characterised by sandy to stony plains with occasional first and second order ephemeral creeks and shallow sandy drainage basins. Granite domes occur scattered throughout the sandy plains, most emerging less than 1 m from the surrounding surface. There are higher ranges approximately 10 km to the east and water sheds from these into the Survey Area through the minor drainages that continue to the Turner River to the west. The presence of water is ephemeral, and no permanent or semi-permanent water is available. Seasonal inundation is not expected to occur as the shallow drainage basins are sandy and no evidence of inundation is present. Vegetation is predominantly open shrublands dominated by Acacia shrubs and Triodia hummock grasses, with the occasional low tree present. Denser and larger trees are present in the drainage features.

Recent fires recorded on the DBCA (2023) database indicate approximately 400 ha burned in 2014, with 80% of the Survey Area being burned in the past 10 years. There are no records of fire in the north west corner. No evidence of recent fire was present during field survey.

Four fauna habitats are described for the Survey Area and are summarised in Table 5-2 and described in detail below, including comparisons to previously described Fauna Habitats at the Pilgangoora Project.

Table 5-2. Fauna Habitats within the Survey Area

Name	Area (ha)	Proportion (%)
Drainage line	0.96	0.2
Granite dome	2.88	0.6
Sandy basin	15.93	3.1
Spinifex open plains	499.18	95.7
Disturbed	2.45	0.5

Fauna habitats are described below. The distribution of fauna habitats is shown in Figure 5-2. Photos of the habitat assessment locations are shown in Appendix D.

Drainage Line

Survey Sites:

MSC032

MSC021

MSC042

AS450085

FH04

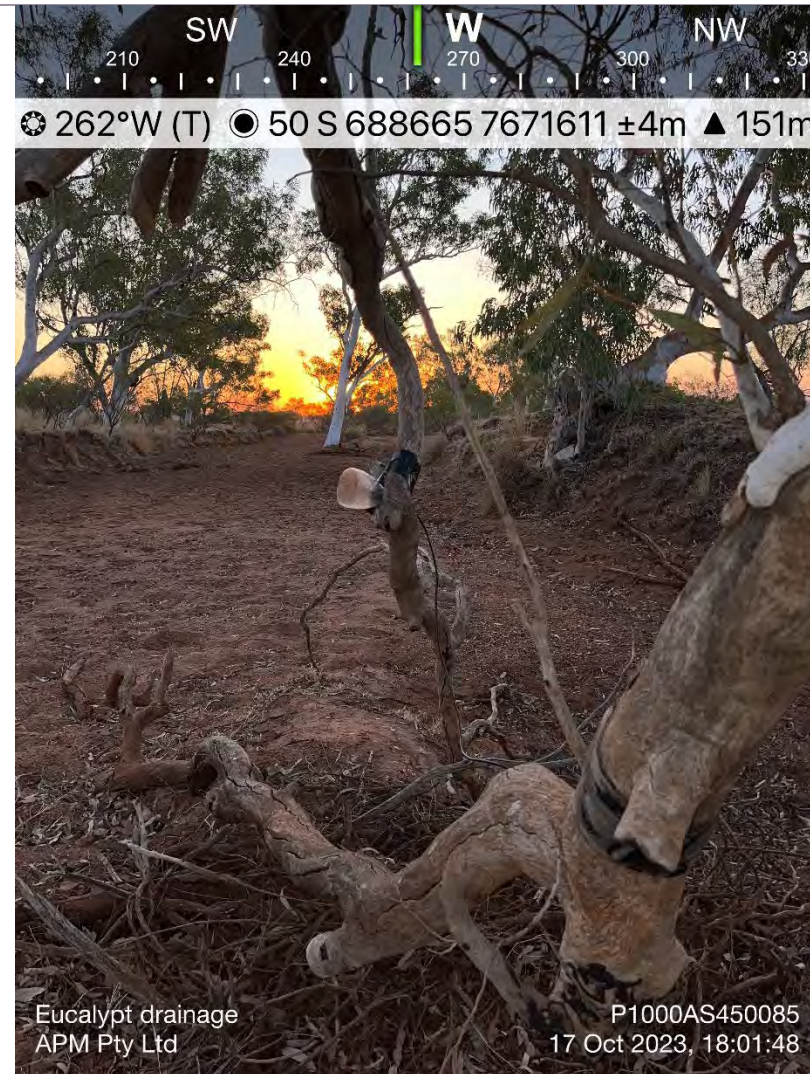
Sandy bottomed ephemeral drainage line, with medium and large trees.

In the Survey Area there are no semi-permanent or permanent pools. Trees provide shading opportunities and tree hollows are present. Large trees are present in places that support many upright very large hollows and some hollow logs large enough for quoll. No fallen hollow timbers are present and litter accumulation is low. Sand in the stream beds is suitable for burrowing species.

Cattle impacts were major with grasses and other understory cover heavily grazed and trampled. The weedy and fire prone introduced fodder grass genus *Cenchrus* is present in low frequency and density. Fire history is of low frequency and intensity.

The vegetation consists of Low open woodland of *Eucalyptus victrix* over *Acacia bivenosa*, *Acacia trachycarpa* and *Acacia stellaticeps* tall open shrubland with *Triodia epactia*, *Triodia wiseana* and *Triodia secunda hummock grassland*.

The confluence with Chinnamon Creek is approximately 1.5 km downstream of this surveyed section of Pilgangoora Creek. The southern boundary of the main Survey Area runs parallel to Pilgangoora Creek and then Chinnamon Creek, approximately 360 m to the south. Within this area there is increased opportunity for ephemeral pools, as can be seen from aerial imagery. The size of trees and presence of redgum and *Melaleuca* increases and fallen hollow timbers become more prevalent. The location where the Survey Area crosses the creek is of lower habitat value than the areas downstream of the confluence.



Granite Dome

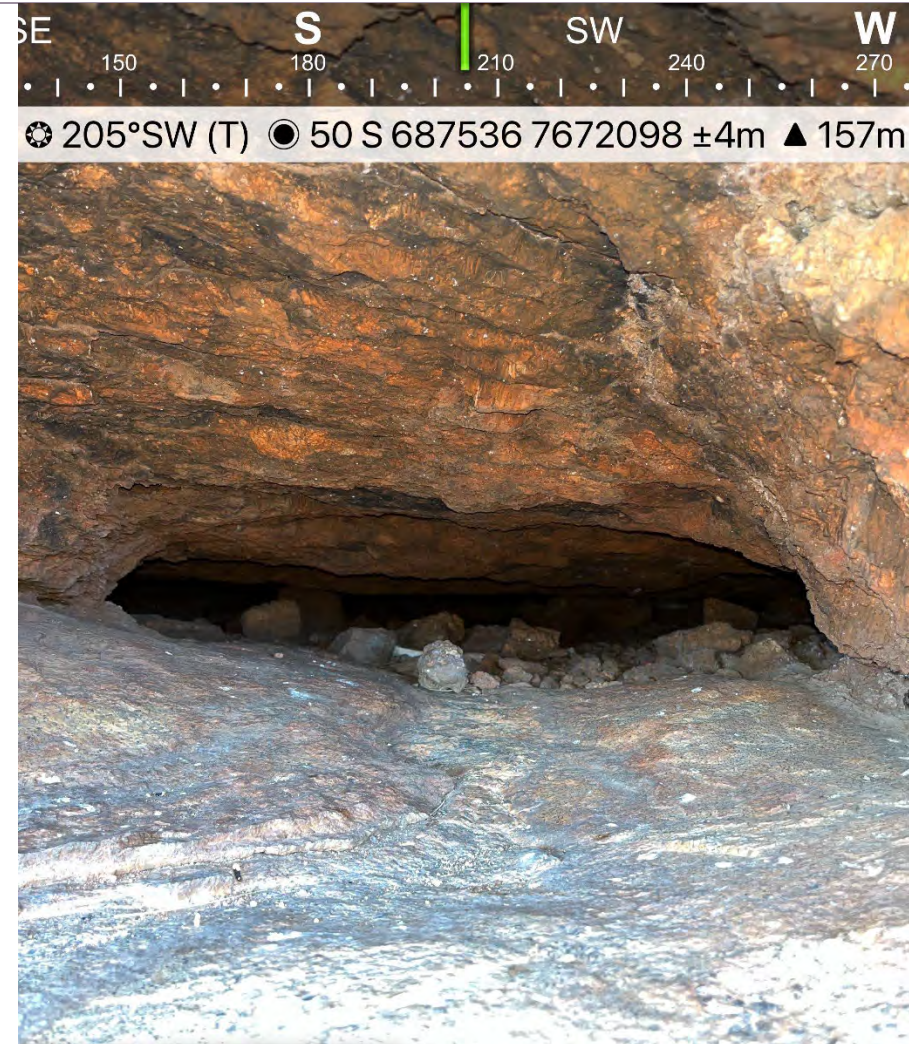
Survey Sites:
MSC036
MSC038
FH01

Flat topped granite domes have a few shallow overhangs at ground level. No boulders are present.

The granite dome in the southern boundary has an overhang approximately 30 m long with multiple entrances.

Overhangs may provide important shelter sites for small and large reptiles such as goannas and snakes, and mammals. The overhangs are sufficient to provide shelter for Pilbara Olive Python and non-breeding denning opportunities for Northern Quoll but are insufficient for the Pilbara leaf-nosed Bat and Ghost Bat.

As the domes are flat and lacking in cracks and crevices there is no soil accumulation and no vegetation on these features. The Granite domes protrude from the Spinifex open plains habitat. Where the domes rise to the surface but do not have overhangs or crevices, they have been mapped as part of the Spinifex open plains habitat.



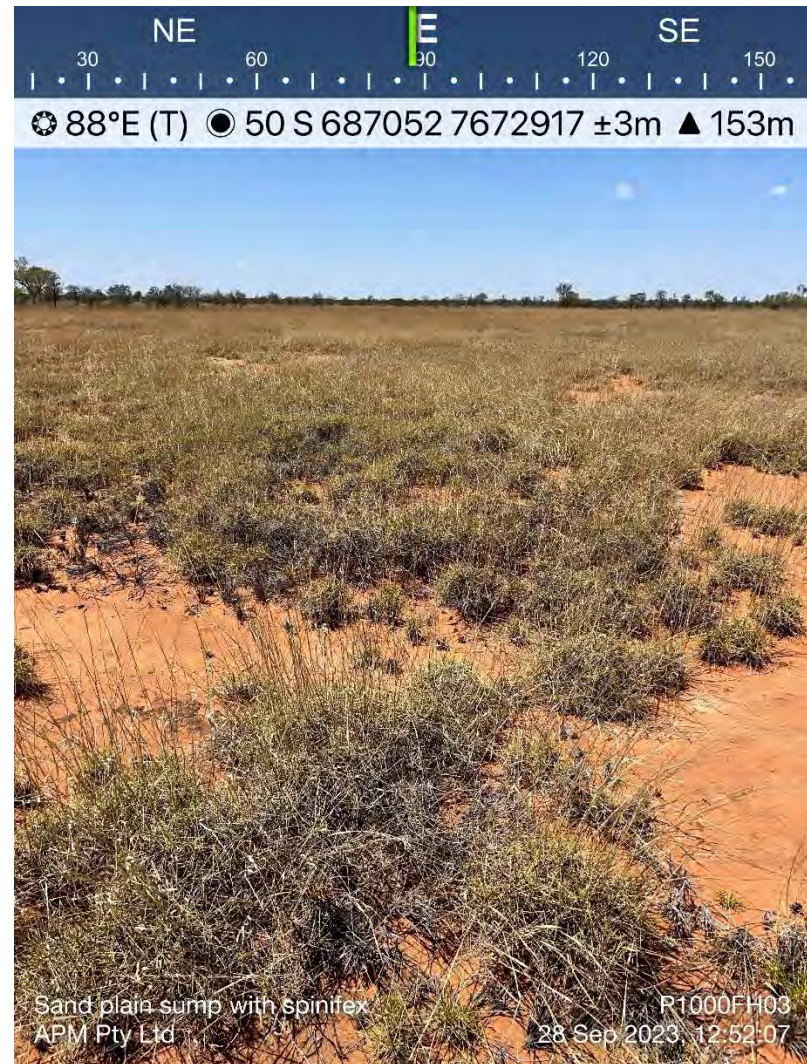
Sandy basin

Survey sites:
 MSC021a
 MSC021x
 MSC030
 FH03

Sandy depressions, low in the landscape that are likely to receive run-on during rainfall. Sand accumulation provides a deep soil profile suitable for burrowing.

This habitat is suitable for Mulgara.

Overstory and shrub midstory vegetation are lacking, with vegetation consisting of mature spinifex grassland, described as Hummock grassland of *Triodia secunda* and *Triodia epactia* with open herbfield of *Pluchea tetranthera*, *Fimbristylis dichotoma* and *Eriachne ciliata*.



Spinifex open plains

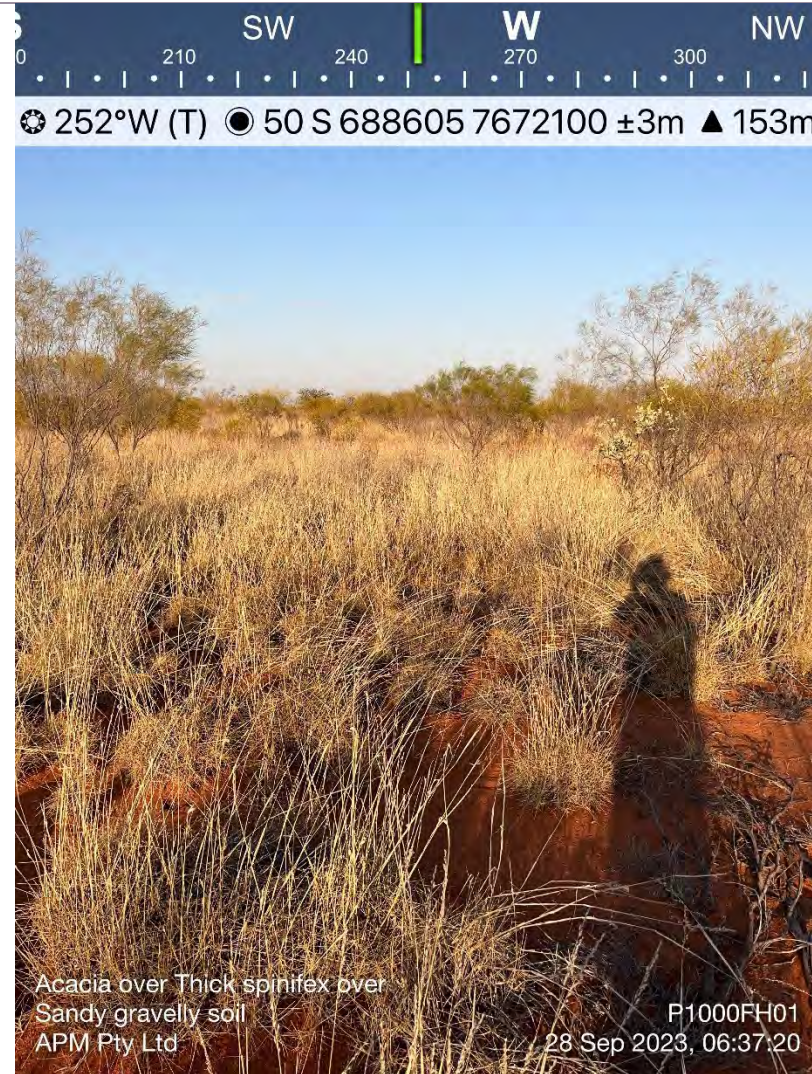
Survey Sites:

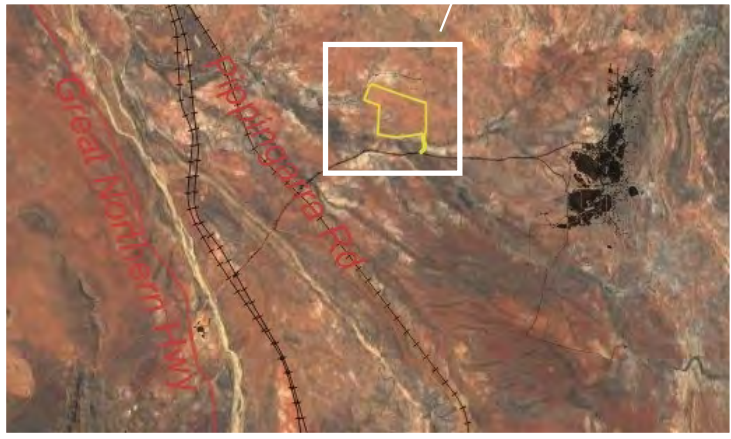
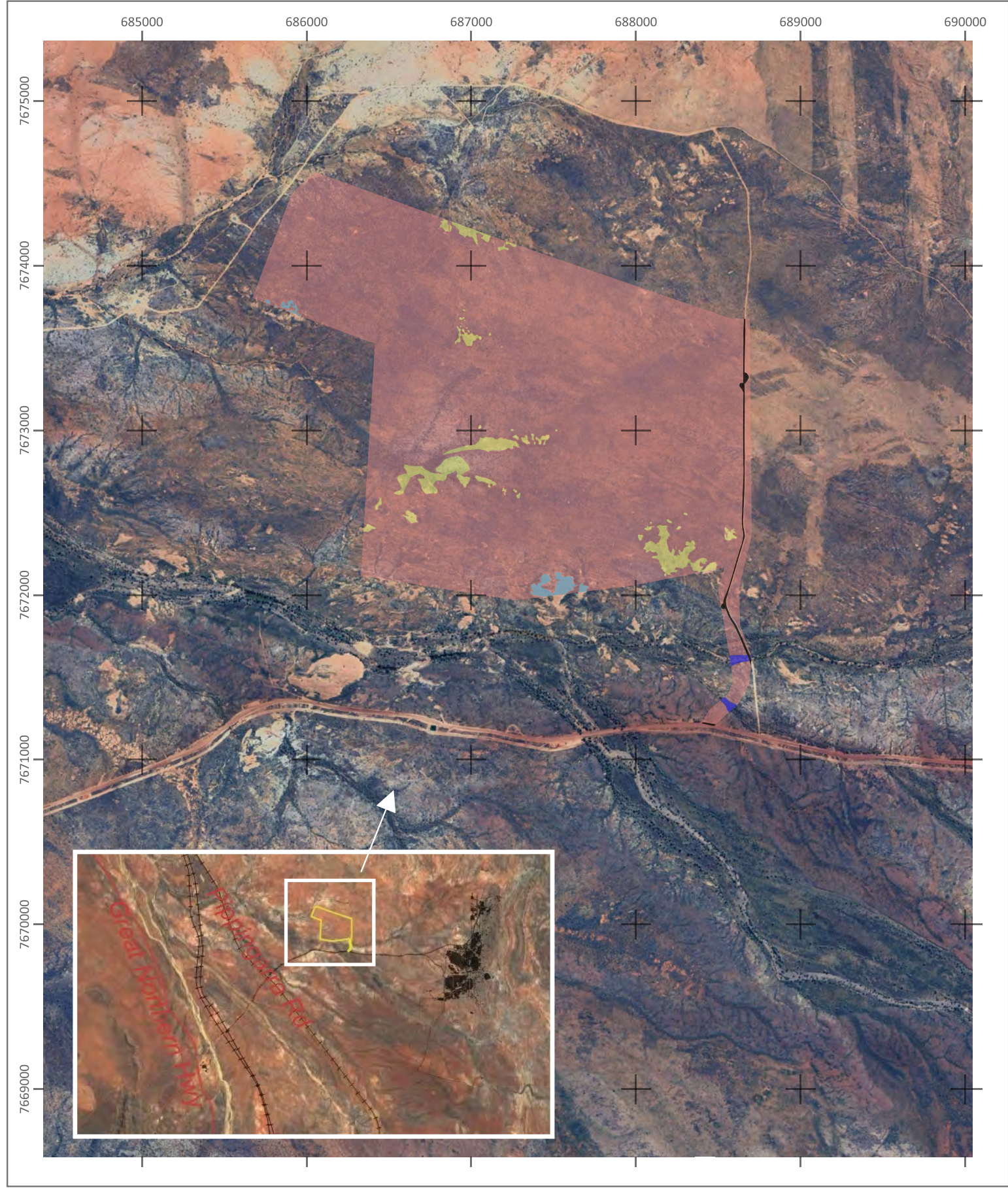
- MSC016
- MSC021a
- MSC021x
- MSC030
- MSC033
- MSC043
- FH02

This habitat type is characterised by its red sandy soils with variable surface pebble/gravel cover, but generally gravel is present. This habitat is typical of the plains described by van Vreeswyk *et al.* (2004) for the Macroy Land System which are interspersed with granite domes and drainage lines.

The sandy substrate is suitable for burrowing species. A sparse and low *Corymbia* overstory is present, offering perching opportunities but with trees too small for hollow development. Large termite mounds are present, but sparsely distributed.

Vegetation consists of isolated low *Corymbia hamersleyana* over mid to tall *Acacia adsurgens*, *Acacia inaequilatera* and *Grevillea wickhamii* sparse tall shrubland with mid hummock grassland of *Triodia lanigera*, *Triodia wiseana* and *Triodia epactia*.






Author: EH Approved: ML Date: 02/01/2024


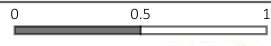
Fauna habitat

Prepared for:




5-2


Scale: @ A4
1: 30,000

Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



Legend

-  Drainage line
-  Granite dome
-  Sandy basin
-  Spinifex Open Plains
-  Disturbed



5.2.2 Acoustic bat recorders

The recording dataset comprised a total of 7 recording nights from one bat detector unit.

Acoustic processing of the bat detector recordings was conducted separately for each of Ghost Bat and Pilbara leaf-nosed Bat using methods optimised for the detection of their unique echolocation call types.

No calls of the Ghost Bat or Pilbara leaf-nosed Bat were in the recordings.

5.2.3 Motion triggered cameras

Conservation significant fauna captured on camera are listed in Table 5-3. Pilbara Olive Python was captured on camera on one occasion, using a termite mound. Mulgara were captured on camera on 12 occasions across three cameras clustered around a burrow complex. The locations and habitats of the captures are discussed on a species basis in Section 5.2.5.

Table 5-3. Targeted fauna camera captures

Camera	Species	Date	Time
MSC033	<i>Liasis olivaceus barroni</i>	23-Oct	21:49:00
MSC016	<i>Dasyercus blythi</i>	8-Oct	01:54:00
MSC021a	<i>Dasyercus blythi</i>	4-Oct	03:32:00
MSC021a	<i>Dasyercus blythi</i>	4-Oct	21:48:00
MSC021a	<i>Dasyercus blythi</i>	4-Oct	22:11:00
MSC021a	<i>Dasyercus blythi</i>	6-Oct	00:46:00
MSC021a	<i>Dasyercus blythi</i>	13-Oct	18:38:00
MSC021a	<i>Dasyercus blythi</i>	14-Oct	04:04:00
MSC021a	<i>Dasyercus blythi</i>	15-Oct	20:15:00
MSC021a	<i>Dasyercus blythi</i>	16-Oct	22:17:00
MSC021a	<i>Dasyercus blythi</i>	16-Oct	23:22:00
MSC021a	<i>Dasyercus blythi</i>	30-Sep	01:07:00
MSC030	<i>Dasyercus blythi</i>	20-Oct	00:19:00

Non-target captures returned a diversity of species, including introduced fauna. Table 5-4 lists the non-target records from cameras.

Table 5-4. Non-target captures from motion triggered and time lapse cameras

Common name	Species	# captures
Black headed Python	<i>Aspidities melanocephalus</i>	3
Brown Tree Frog	<i>Litoria rubella</i>	1
Cat	<i>Felis catus</i>	59
Cow	<i>Bos taurus</i>	11
Desert Mouse	<i>Pseudomys desertor</i>	3
Fat-tailed Dunnart	<i>Sminthopsis crassicaudata</i>	56

Common name	Species	# captures
Fire-tailed Skink	<i>Morethia ruficauda</i>	2
Geyhra	<i>Gehyra pilbara / variegata</i>	1
Goulds Monitor	<i>Varanus gouldii</i>	7
King Brown	<i>Pseudechis australis</i>	2
Magpie Lark	<i>Grallina cyanoleuca</i>	8
Military Dragon	<i>Ctenophorus isolepis</i>	4
Narrow-banded Sand-swimmer	<i>Eremiascincus fasciolatus</i>	7
Painted Firetail	<i>Emblema pictum</i>	1
Panther Skink	<i>Ctenotus pantherinus</i>	6
Perentie	<i>Varanus giganteus</i>	3
Pied Butcher Bird	<i>Cracticus nigrogularis</i>	4
Rock Rat	<i>Zyzomys argurus</i>	3
Sand-plain Gecko	<i>Lucasium stenodactylum</i>	3
Singing Honeyeater	<i>Lichenostomus virescens</i>	9
Spiny Tailed Monitor	<i>Varanus acanthurus</i>	4
Unidentified Dragon		1
Variegated Wren female	<i>Malurus lamberti</i>	18
White Faced Heron	<i>Egretta novaehollandiae</i>	5

Identifications were only made as far as necessary to rule out target species, however all captures were able to be identified to the species level except one capture of a dragon species.

5.2.4 Traverses

During traverses, the following fauna signs were identified:

- One patch approximately 4 m x 3 m with a fresh burrow complex containing at least 4 entrances;
- One burrow that appears to be an abandoned mulgara burrow; and
- One small digging and scat that is suspected to belong to mulgara.

Notes were taken on habitat quality, disturbances, and the availability/unavailability of habitat micro-niches. Specific habitat features recorded included:

- large termite mounds (*e.g.* Plate 5-1);
- granite domes with overhangs or crevices; and
- trees large enough to support hollow development.

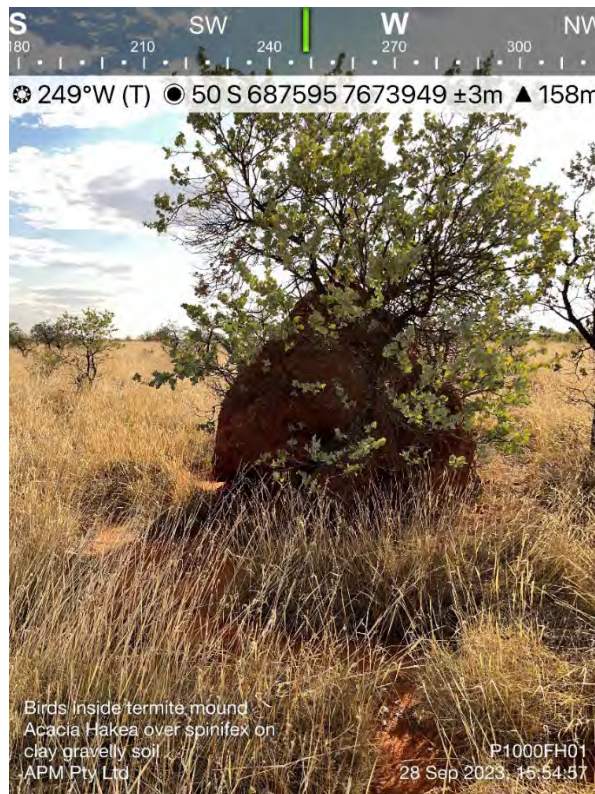


Plate 5-1. Large termite mound

Signs and available habitats of conservation significant fauna are discussed further in Section 5.2.5 below.

5.2.5 Conservation Significant Fauna

5.2.5.1 Pilbara Olive Python

The Pilbara Olive Python has been recorded frequently in the Pilgangoora area, most commonly in the rocky outcrops in the elevated ranges. Out of 56 records of the species within 100 km of Pilgangoora, only one has been recorded in a riparian environment – in the Turner River area.

The Pilbara Olive Python prefers deep gorges and water holes in the ranges of the Pilbara region (Pearson 1993). Radiotelemetry has shown that individuals spend the cooler winter months hiding in caves and rock crevices away from water sources. In the warmer summer months, the pythons were found to move around widely, usually in close proximity to water and rock outcrops (Swan 2007). Prey is captured by ambush on animal trails or by striking from a submerged position in water holes (Pearson 2006). The subspecies is adept at swimming, utilising water holes to hunt and its diet includes Rock wallabies, Fruit Bats, ducks, Spinifex Pigeons and Coucals (Threatened Species Scientific Committee [TSSC] 2008) Ellis and Johnstone (2016) and Ellis (2013) consider that birds, particularly waterbirds, are likely to make up a large portion of the diet of adult Pilbara Olive Python due to its frequent association with water bodies.

At the P1000 area, the species was captured on camera exiting a large termite mound (Plate 5-2). During the camera survey period the mound was also used by a variety of bird and reptile species, the Fat-tailed Dunnart, and a cat.

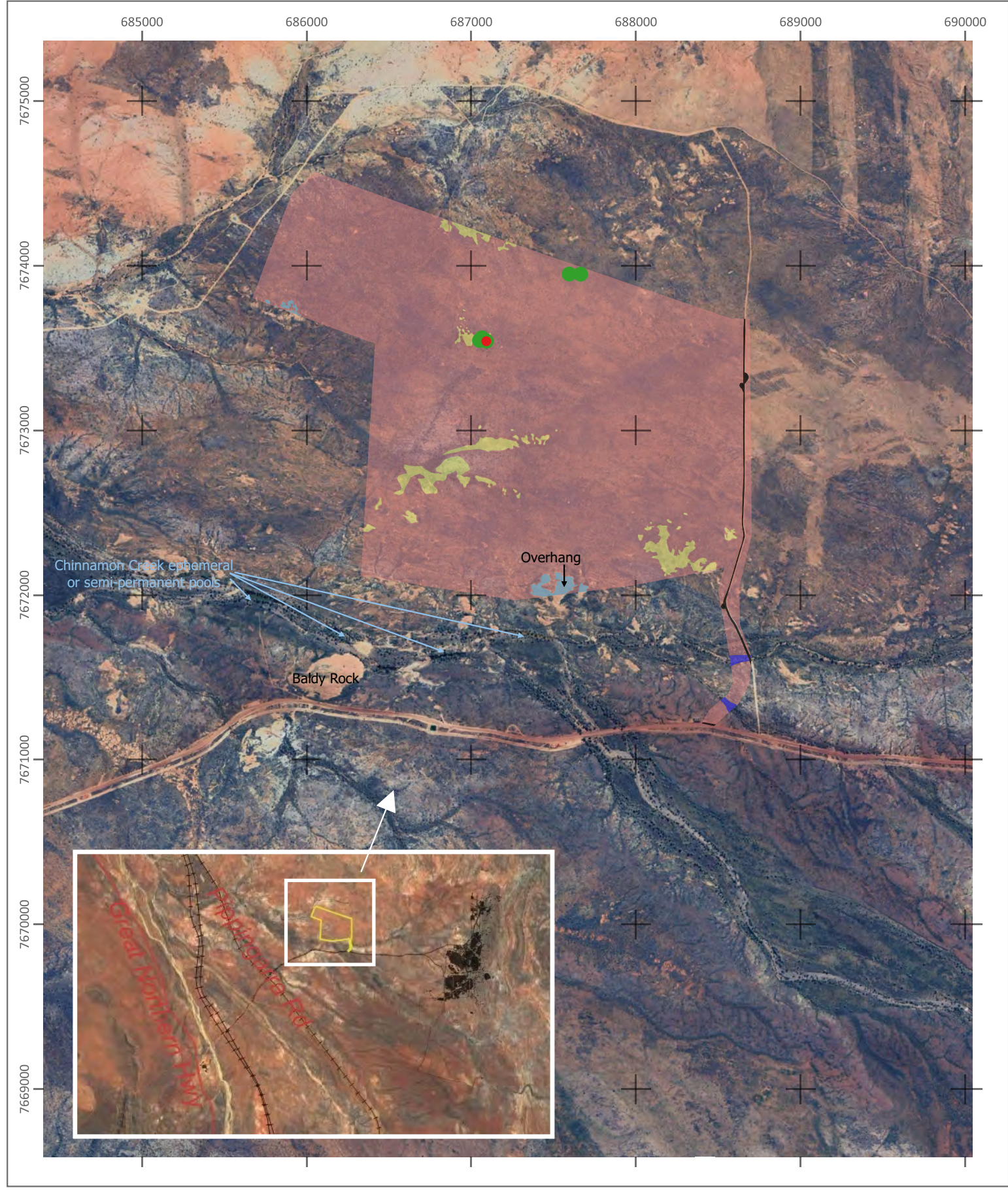
Termite mounds are not recognised as important habitat for the Pilbara Olive Python and no reference to use of termite mounds was able to be found in the literature. The use of a termite mound by the Pilbara Olive Python on this occasion is considered a novel finding. It is possible that termite mound usage is a dispersal strategy, with the individual requiring refuge whilst moving between more suitable habitats.

Five termite mounds were recorded in the P1000 Survey Area, in two locations. The location of termite mounds and the location of the Pilbara Olive Python camera capture are shown in Figure 5-3. Termite mounds were recorded within the Spinifex Open Plains habitat. Additional termite mounds were noted as occurring past the northeast corner of the Survey Area.

Other habitat available in the Survey Area that is suitable for Pilbara Olive Python includes the Granite Dome overhang in the southern boundary of the Survey Area. The overhang would provide diurnal refuge to the Pilbara Olive Python in close proximity to the ephemeral or semi-permanent pools in Chinnamon Creek 0.7 to 1.8 km to the southwest. The overhang in the Survey Area is approximately 30 m long with multiple entrances. An additional Granite Dome overhang of similar size is available at Baldy Rock, 650 m south of the Survey Area southwest corner. These two granite domes provide the largest overhang/crevice type refuges in the local area. Other granite outcrops in the area have very small overhangs or crevices and overhangs are absent.




Plate 5-2. Termite mound showing MSC033 setup (left) Pilbara Olive Python leaving the termite mound (right)



Author: EH Approved: ML Date: 08/01/2024


Pilbara Olive Python

Prepared for:




5-3

Scale: @ A4
1: 30,000



Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



Legend

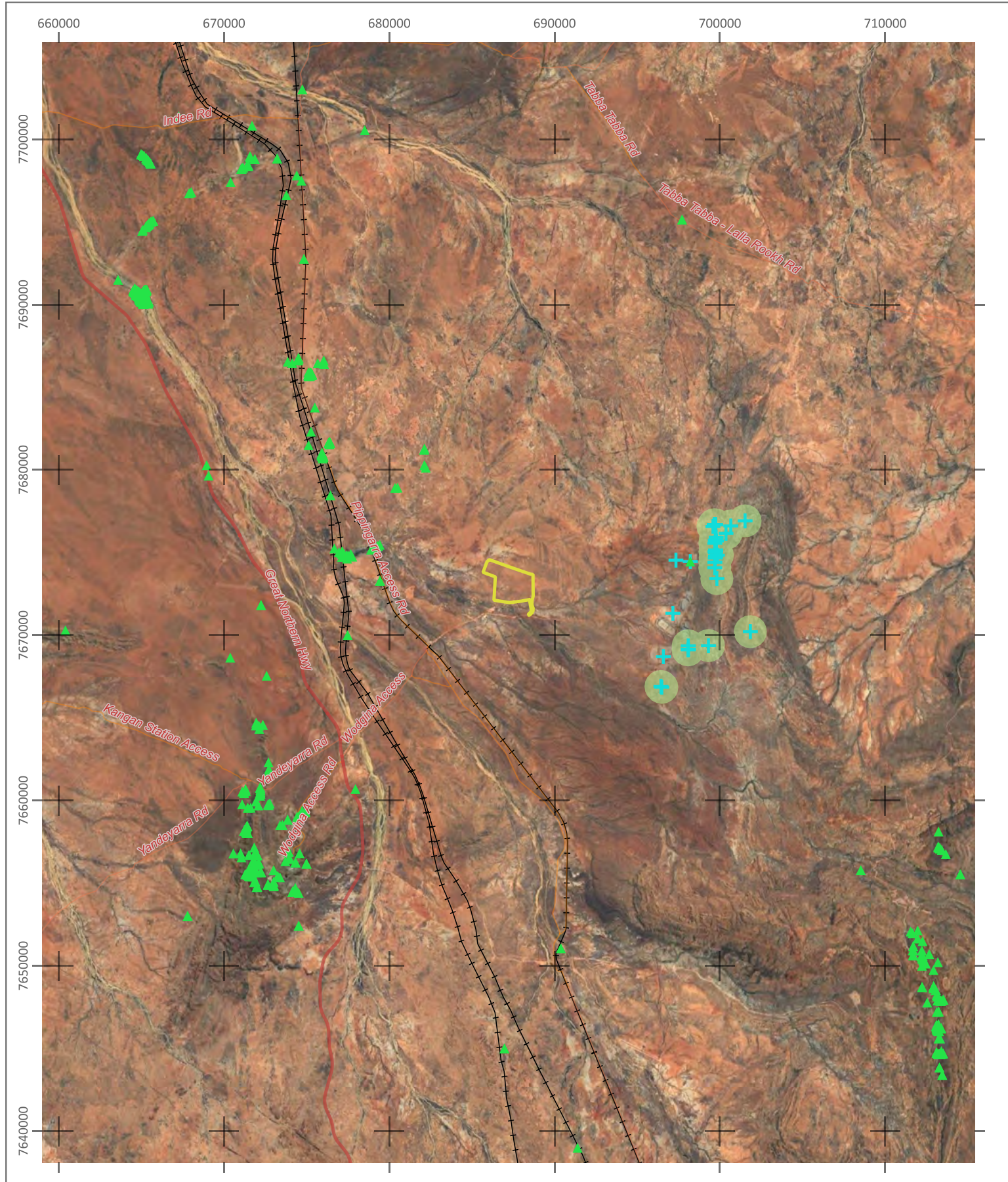
- Pilbara Olive Python record location
 - Termite mound
- Fauna Habitat**
- Drainage line
 - Granite dome
 - Sandy basin
 - Spinifex Open Plains
 - Disturbed



5.2.5.2 Northern Quoll

Northern quoll have been recorded on several occasions within the Pilgangoora Project Area (DBCA Database record, Ecologia Environmental 2018; Terrestrial Ecosystems 2020, APM 2022a, APM 2023b, APM unpublished data [Figure 5-4.]). Locally this species seems to be most encountered in the boulder hill tops habitat of the north/south tending ridgeline running along the eastern half of the Pilgangoora Project Area. This is the most rugged landform in the local area, at the highest elevation. Boulders on the ridge tops form a mosaic of cracks and crevices large enough to provide denning habitat for the quoll. Habitat critical to the survival of the Northern Quoll and populations important for the long-term survival of the Northern Quoll, as defined in CoA (2016), occur in the boulder hill tops habitats.

Within 30 km of the Survey Area, species records predominantly occur within rocky outcrop habitats, but also occur in the Turner River and larger tributaries of the Turner River, 11 km to the west of the Survey Area. Quoll have been recorded near to mine infrastructure of the Pilgangoora Project on three occasions.



Author: EH Approved: ML Date: 05/01/2024

Northern Quoll

Prepared for:
5-4
 Scale: @ A4
 1: 300,000
 Coordinate System: GDA 2020 MGA Zone 50
 Projection: Transverse Mercator

Legend

- P1000 Survey Area
- 1 km buffer Northern Quoll critical habitat
- Pilbara Minerals Quoll Records
- DBCA database Quoll records



No evidence of habitat usage within the Survey Area was recorded, and rocky boulder outcrop habitat critical to the survival of the species (CoA 2016) is absent. The granite outcrop in the southern part of the Survey Area contains overhangs suitable for denning and foraging opportunities, however no camera captures were made, or signs of recent usage recorded.

All habitats occurring within the Survey Area may be utilised by the species, at some time, to forage and or during dispersal activities; however, their significance to the species will vary depending on resource availability and connectivity. At the time of survey there is no evidence of consistent use of the Survey Area by Northern Quoll and the Survey Area is outside the 1 km buffer of critical habitats (Figure 5-4.), indicating it is not important habitat for the sustainability of the local population, but may be used periodically.

5.2.5.3 Ghost Bat

A recent review of Ghost Bat (Bat Call WA 2021a) updates the knowledge base on ecology, threats, and survey requirements for the species.

Ghost bats move between a number of caves seasonally or as dictated by weather conditions and/or foraging opportunities, so they require a range of cave sites (Richards *et al.* 2008). They disperse widely when not breeding but may concentrate in relatively few roost sites when breeding. In the Pilbara, except for the large, abandoned mine colonies, Ghost bats are often present either singly or in small groups (usually less than 15). These have been shown to move periodically, either seasonally or as dictated by prey availability. Their vagrant foraging strategy relates to patchy, locally unreliable rainfall events (and prey biomass) across much of its foraging habitat in the Pilbara and elsewhere in other semi-arid parts of its broader Australian range. Hence the relatively small groups that must move from roost to roost to access their ephemeral patchy food resource.

Extensive survey activity in the last decade has led to the proposal of four categories of roosting habitat used by Ghost bats in the Pilbara (Cramer *et al.* 2022; Bullen 2021a):

- Category 1 permanent diurnal roost;
- Category 2 regular diurnal roost;
- Category 3 occasional diurnal roost; and
- Category 4 nocturnal feeding roosts.

Within the Survey Area there are no Category 1, 2, 3 or 4 roosts available to this species.

In the Pilbara, Ghost bats prefer to forage on productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (*Triodia spp.*) on sand or stony ground. Isolated trees and trees on the edge of thin thickets on the plains, or trees along the edges of watercourse woodlands, appear to be preferred vantage points (Bullen unpublished data, reported in Bullen 2021). In the Survey Area there are scattered to clumped trees available for perching in all habitat types.

No Ghost bats were recorded during the acoustic survey, however acoustic recorders are not suited to Ghost bat detection during foraging as the species seldom uses its echolocation away from caves.

The Ghost Bat is listed in the PMST as known to occur within the local area and the DBCA database has records for the species within a 30 km radius. APM (2023b) recorded Ghost bat on camera in a location 10 km northwest of the Survey Area in a Category 4 roost. Ghost bats are known to travel up to 15 km

from a roost site for foraging and up to 30 km in one night to alternative roosting sites, indicating the Survey Area may be within range of Category 1, 2 or 3 roosts.

It is likely that the Survey Area offers foraging habitat to Ghost Bat across all habitat types.

5.2.5.4 Pilbara Leaf-Nosed Bat

A recent review of Pilbara leaf-nosed Bat (Bat Call WA 2022b) updates the knowledge base on ecology, threats, and survey requirements for the species. It is generally encountered in rocky areas that provide opportunity for roosting, in particular the ironstone Hamersley Range, the ridgelines granite boulder piles and disused mines of the eastern Pilbara, and along medium and major drainage lines that radiate away from rocky uplands.

Pilbara leaf-nosed Bat roost during the day beyond the twilight zone in caves and underground mines with stable, warm and humid microclimates because of its poor ability to maintain its heat and water balance (Churchill *et al.* 1988; Jolly 1988; Churchill 1991; Baudinette *et al.* 2000; Armstrong 2001). The Pilbara leaf-nosed Bat does not roost in overhangs (shallow structures where the rear wall can be observed from the entrance), as these do not support warm, humid microclimates (TSSC, 2016). A suggestion that this species becomes 'forest dwelling' in the wet season of the monsoonal northern areas (Churchill 1991) has not been supported, and is very unlikely in the Pilbara region (Armstrong 2001).

Roosts have been categorised according to importance to the survival of the species into four categories (TSSC 2016):

- Category 1 - Permanent diurnal maternity roosts where seasonal presence of young is proven;
- Category 2 - Permanent diurnal roosts where presence of young is unproven;
- Category 3 - Semi-permanent diurnal roosts; and
- Category 4 - Nocturnal refuge.

The Pilbara leaf-nosed Bat was recorded locally during Targeted survey for individuals and roosts for the Pilgangoora Project (360 Environmental 2015, 2016). A Category 1 or 2 roost was located, and high-quality foraging habitat was identified at a major water body in an abandoned open cut pit. The roost site and confirmed foraging habitat are 13 km northeast of the Survey Area and are shown in Figure 5-5. An estimate of the number of Pilbara leaf-nosed bat at the roost based on ultrasonic calls and video counts ranged between 25-50. There are additional known permanent diurnal category 1 or 2 Pilbara leaf-nosed bat roosts within 40 km of the Survey Area (Bat Call WA 2022b), and Category 4 Roosts have been recorded to the east of the Pilgangoora Project (APM 2023c). The Survey Area does not contain any Category 1, 2, 3 or 4 roosts.

Generally, the Pilbara leaf-nosed Bat is most encountered within 20 km of its permanent diurnal roosts (Bullen 2013), but in the months where climatic conditions are least challenging for the species (April-May) they have been recorded further afield (Bat Call WA 2022b). Echolocation based records indicate that it can complete round trips of 50 km or longer in a night under favourable conditions (Bat Call WA 2022b).

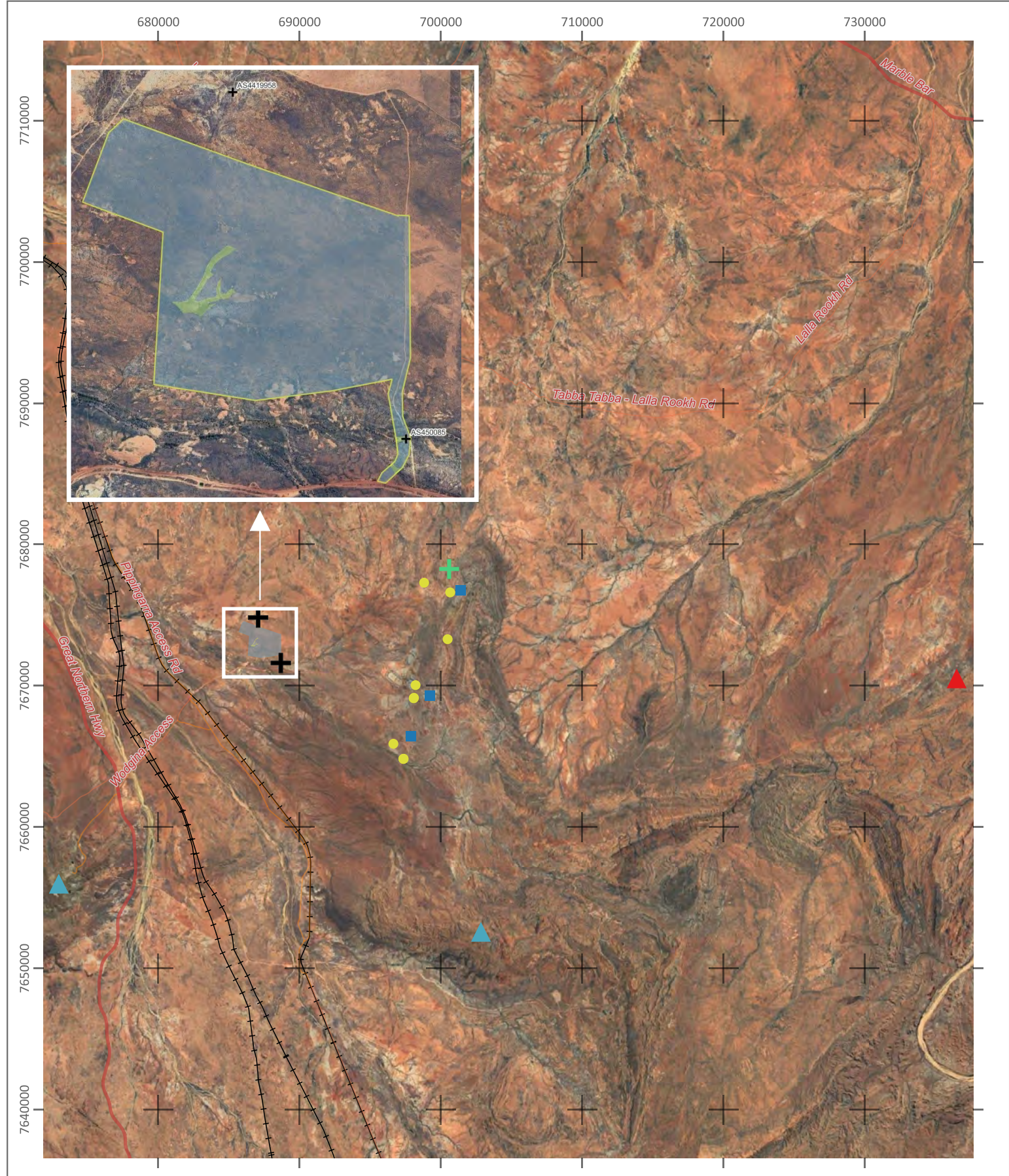
No call sequences of the Pilbara leaf-nosed Bat were recorded within the Survey Area.

Foraging habitats used by the Pilbara leaf-nosed Bat are prioritised by EPBC Conservation Advice (TSSC 2016) as:

- Priority 1 - Gorges with pools;
- Priority 2 – Gullies;
- Priority 3 – Rocky Outcrop;
- Priority 4 – Major Watercourses; and
- Priority 5 – Open Grassland and Woodland.

Habitats in the Survey Area have been categorised using this Priority schedule and are shown in Figure 5-5 where Priority 4 areas include the Drainage Lines and the remaining habitats are Priority 5.

Whilst the Pilbara Leaf-nosed Bat is known to occur in the local area, the Survey Area does not present habitat that is of high priority for conservation of the species.



Author: EH Approved: ML Date: 05/01/2024

Pilbara Leaf-nosed Bat

Prepared for:
5-5
 Scale: @ A4
 1: 350,000
 Coordinate System: GDA 2020 MGA Zone 50
 Projection: Transverse Mercator

Legend

- PILNB and Ghost Bat records Pilgangoora
- ▲ Confirmed Category 1 Roost
 - + Confirmed Category 1 or 2 Roost
 - ▲ Confirmed Category 2 or 3 Roost
 - Category 4 Roost
 - Previously recorded Priority 1 foraging habitat
- Forging habitat categories within the Survey Area (inset)
- Priority 4 foraging habitat PILNB
 - Priority 5 foraging habitat
- + Acoustic survey locations

5.2.5.5 Grey Falcon

The Grey Falcon occurs in most of the drier parts of Australia (Schoenjahn 2018). Its distribution is centred on inland drainage systems where there is an average annual rainfall of less than 500 mm. Its main habitat is timbered lowland plains, particularly Acacia shrublands that are crossed by tree-lined watercourses. It generally occurs at low densities across inland Australia (BirdLife International 2019).

The Grey Falcon hunts far out into tussock grassland and open woodland. It nests in old nests made by other birds, usually nests in the tallest trees along watercourses, particularly river red gum (TSSC 2020). Prey species include doves, pigeons, small parrots and cockatoos, and finches, but a variety of other bird prey species has been recorded, as well as mammals and lizards (TSSC 2020).

Local records are centred on the Turner River and major tributaries. The closest record is 9 km from the Survey Area to the west. The Survey Area is suitable foraging habitat for this species, and within range of the population likely to be nesting in the Turner River riparian zone. No red gum trees were present in the Drainage Line fauna habitat within the Survey Area and no nests were observed. Larger trees including red gum, become frequent from the confluence of Pilgangoora Creek with Chinnamon Creek, to the west of the intersection of the Survey Area with the creek.

5.2.5.6 Night Parrot

The Survey Area is within the area where Night Parrot is modelled as *may occur*. Very limited information is available on the Night Parrot, however some information on habitat characteristics where the species has persisted is available.

DBCA (2017) summarises habitat characteristics. Night parrot roosting and nesting sites are in clumps of dense vegetation, primarily old and large spinifex (*Triodia*) clumps, but sometimes other vegetation types. Often the vegetation in these habitats will be naturally fragmented and therefore well protected from fire. Little is known about foraging sites, but favoured sites are likely to vary across the range of the species. In Queensland, Night parrots have been shown to feed in areas rich in herbs including forbs, grasses and grass-like plants, and it is likely that such areas may also be important in WA. *Triodia* is likely also to provide a good food resource for Night Parrot, in times of mass flowering and seeding, but they also rely heavily on a range of other food species. *Sclerolaena* has been shown to be a source of food and moisture.

The species and growth pattern of the spinifex in some of the plains habitat in the Survey Area may be suitable for the Night Parrot, however there are no patterns of fragmentation and fire records (DBCA 2022) and field observation show that burning is often landscape scale and at a moderate frequency. There are no samphire or chenopod habitats proximal to the Survey Area, however the drainage depressions may seasonally support a diversity of herbs and other potential forage species. Night parrots have been known to fly up to 40 km or more in a night during foraging expeditions, so foraging habitat is not necessarily within or adjacent to roosting areas.

An interim guideline for preliminary surveys of Night parrot in WA (DPAW 2017b) identifies when and where Night parrot surveys may be required. The Survey Area is on the north-western edge of the area classed as a high priority for survey. Due to the inclusion of the site in the high priority survey area and the presence of potentially suitable spinifex habitat, passive acoustic survey was conducted in three

previous surveys (APM 2022a, APM 2022b and APM 2023b). No Night parrot calls were recorded and foot traverses have not encountered any signs or individuals of Night Parrot.

While the habitat is potentially suitable, there are no historic records of Night Parrot in the area and very few records of extant individuals. While it remains possible that the species could colonise in the future, there is no evidence that they are currently present.

5.2.5.7 Greater Bilby

Extant populations of bilby occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils (typically sandy for burrow excavation). Bilby occupies three major vegetation types; open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate 1990). Laterite and rock feature substrates are an important part of Greater bilby habitat, which support shrub species such as Acacia, and spinifex hummocks which are quite uniform and discrete, providing runways between hummocks, enabling easier movement and foraging (Southgate *et al.* 2007).

The species is identified by the PMST as known to occur within 30 km of the Survey Area. Database results returned 104 records within a 30 km radius of the Survey Area, the closest being one record to the east of Pilgangoora made in 1979. Recent records (2012–2016; 16 to 25 km west) are from surveys conducted for the rail and road corridors to the west. These records are surrounding the Turner River. The DBCA has a long-term bilby abundance monitoring program at the Turner River (DPAW 2017a).

All habitats in the Survey Area are suitable for Greater Bilby. Extensive foot transects were walked across all habitats. No burrows were located or scratching/diggings etc that may be attributable to bilby activity.

This species has the potential to occupy the Survey Area as bilbies can be relatively transient across their distribution. No burrows were observed suggesting any current use may be for foraging only and transitory in nature.

5.2.5.8 Brush-tailed Mulgara

Brush-tailed Mulgara is widespread, but patchily distributed in sandy regions of arid central Australia and WA. It inhabits hummock grass plains, sand ridges, and mulga shrubland on loamy soils (Menkhorst and Knight, 2010). It uses the open space between vegetation, a microhabitat that is known to support important prey species and may forage in termite mounds (Molyneux *et al.* 2018).

The Brush-tailed mulgara constructs burrows or utilises those of other species. Burrows may provide access to prey items, protection from predators and have thermoregulation benefits (Molyneux *et al.* 2018).

Local database records are to the south and west of the Survey Area with the closest record 10 km to the south. Records originate from biological surveys assessing the impact of rail lines servicing the Pilbara region.

One burrow complex was recorded during traverses searching for signs of the species. Cameras were deployed and Mulgara were captured on 12 occasions over a 26-day period from three cameras that were clustered together around the burrow complex. Shallow digging and a suspected mulgara scat were recorded 100 m to the east and an abandoned burrow was recorded 460 m east northeast.

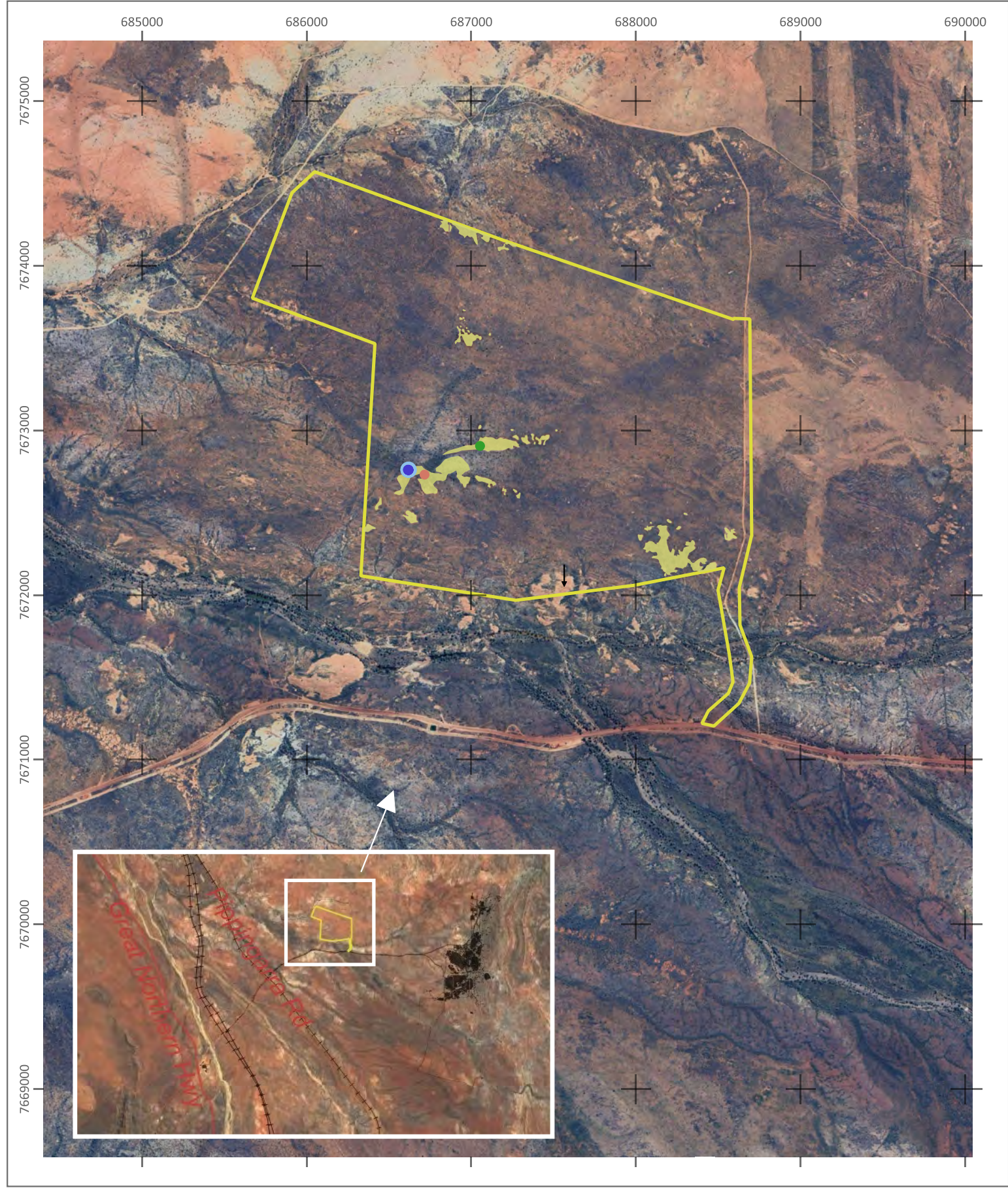
Suitable habitat occurs in the Sandy basin habitat. These areas have a deep sandy soil profile, large spinifex hummocks and are suitable for burrowing.



Plate 5-3. Mulgara signs




Plate 5-4. Brush-tailed Mulgara camera capture



Author: EH Approved: ML Date: 08/01/2024


Brush-tailed Mulgara

Prepared for:




5-6

Scale: @ A4
1: 30,000



Coordinate System: GDA 2020 MGA Zone 50
Projection: Transverse Mercator



Legend

- Mulgara record location
- Fresh Mulgara burrows
- Old Mulgara burrow and pop-hole. Not currently in use.
- Possibly small Mulgara digging and scat
- Sandy basin habitat



5.2.5.9 Spectacled Hare-wallaby (mainland)

The Spectacled hare-wallaby inhabits tropical tussock or hummock grassland with mid-dense or sparse tree and shrub cover (Menkhorst and Knight, 2010). In the Pilbara this species has declined drastically, possibly due to fox predation and because frequent burning of spinifex grassland has prevented the development of the large hummocks required for shelter (Van Dyck and Strahan 2008).

There are many local records, in the surrounding foothills and plains habitats. These records are from the early 1990's.

The species was not recorded during the detailed and reconnaissance fauna surveys for the Pilgangoora Project (See Section 3.1.2), with the absence of the species attributed to the broader regional decline. Scats recorded in two subsequent studies (APM 2022b, APM 2023d) were determined to be likely of belonging to the Spectacled hare-wallaby. The habitats available in the Survey Area, particularly in the Shallow Drainage Depressions and Creeks where the scats were recorded, offer a denser cover of vegetation that may be providing sufficient shelter from predation for the species to persist locally.

5.2.6 Introduced Fauna

The field survey identified the presence of two introduced fauna species.

Eleven camera captures from two locations were of cattle, which is expected as the land is within a station and pastoralism is the active land use within all surveyed areas.

Fifty-nine camera captures of cat were from one camera, focused on a termite mound. Markings indicate this is one individual. The animal appears to be residing in the termite mound with several captures a day of the animal entering and exiting the mound. The mound is also the location where the Pilbara Olive Python was recorded and is 600 m north of the location where Mulgara were recorded.

6 CONCLUSIONS

6.1 FLORA

The flora and vegetation survey recorded a total of 61 taxa within the Survey Area which is lower than the number of taxa recorded in other previous local surveys: 120 taxa (67 genera from 28 families) recorded by APM (2022b) for TSF Options 2 and 5, 118 taxa (67 genera and 25 families) recorded by APM (2023b) for the TSF Infill Survey, 116 taxa (63 genera from 26 families) recorded by APM (2022a) at the Lynas Find Deposit; 195 taxa (101 genera and 39 families) recorded by MMWC Environmental (2016a) at the Pilgangoora Project, and 122 taxa (67 genera and 38 families) recorded by Outback Ecology (2009) at Wodgina.

The lower diversity reflects the smaller survey area with a low diversity of habitats, but also the season of survey and seasonal conditions. Modelling indicates that the survey captured 68% of the species richness and it would be expected that a greater diversity of annual and ephemeral species would be present following rainfall. In comparison to previous surveys, the flora and vegetation of the Survey Area is generally typical of the Pilbara, and of the adjacent lands surrounding the Survey Area.

6.2 FLORA OF CONSERVATION SIGNIFICANCE

No T flora was recorded in the Survey Area. Two Priority flora species were recorded.

Triodia chichesterensis (P3) was recorded in one location in the northwest corner of the Survey Area. It co-occurs with the closely related *Triodia lanigera* and, as is common in the northern part of the species range, the distribution of the two species is generally substrate based with *T. chichesterensis* restricted to areas where quartzite is commonly found at the surface. Quartzite is common in the local area and not all areas containing quartzite host *T. chichesterensis*.

Euploca mutica (P3) was recorded in two locations within the Undulating Plains habitat, which is typical of the described habitat of the species. Where it occurred, it was recorded at low abundance and distribution. An additional eight locations have been recorded for the species across the Pilgangoora Project, all occurring in the Undulating Plains habitats. The species appears to be common in the local area but sparsely distributed over a wide area.

An additional three species were determined likely to occur based upon the availability of suitable habitat. One of these, is a perennial species, *Gymnanthera cunninghamii* (P3) identifiable from vegetative parts and would have been detectable at the time of survey. Two species (*Goodenia nuda* [P3] and *Rothia indica* subsp. *australis* [P3]) are annual species. Seasonal conditions were unsuitable for the presence of these species to be detected.

6.3 INTRODUCED FLORA

No weeds Declared under the BAM Act or classed as WoNS were recorded in the Survey Area. Two weeds were recorded, both species of agricultural grass *Cenchrus ciliaris* and *Cenchrus setiger*. Occurrence was infrequent and where present, they occurred in low numbers.

Declared weeds known to occur in the region are perennial species able to be identified from vegetative parts. The absence of Declared weeds within the Survey Area is reported with a high level of confidence.

6.4 VEGETATION OF CONSERVATION SIGNIFICANCE

There are no recognised TECs or PECs located within or adjacent to the Survey Area.

None of the vegetation types described for the Survey Area are analogous to any known TECs or PECs. The nearest record of a TEC or PEC to the Survey Area is the Gregory Land System (P3 PEC), approximately 50 km away.

The Chichester Subregion includes seven Ecosystems at Risk which are subject to a range of threatening processes (Kendrick and McKenzie 2001). None of these ecosystems are relevant to the Survey Area.

One species associated with Groundwater Dependent Ecosystems was recorded. *Eucalyptus victrix* was recorded in vegetation type 4b in Pilgangoora Creek. Individuals were relatively old with a large diameter at breast height compared to other trees in the surrounding habitats. *Eucalyptus victrix* is regarded as being a facultative phreatophyte that most likely draws the majority of its water requirement from the unsaturated zone but can use groundwater opportunistically as required (Pfautsch *et al.* 2014), when available within reach of the root zone, typically thought to be up to 10 m.

Regional Vegetation Associations within and nearby the Survey Area as described by Beard have over 99% pre-European Vegetation extent remaining. Conservation significance ranking of vegetation associations occurring within the Survey Area are of 'Least Concern'.

6.5 FAUNA OF CONSERVATION SIGNIFICANCE

The Pilbara Olive Python is known to occur in the local area from DBCA database records but has not previously been recorded at the Pilgangoora Project. The species local records are generally confined to the rocky ranges, with occasional records in the riparian areas. The Pilbara Olive Python was captured from a motion triggered camera leaving a large termite mound in the P1000 Survey Area. Termite mounds are not commonly recognised as important Pilbara Olive Python habitat and this record is considered novel. Other suitable habitat for Pilbara Olive Python present in the Survey Area is the large overhang in the Granite Dome habitat.

The Mulgara is known to occur in the local area from DBCA database records but has not previously been recorded for the Pilgangoora Project. In the P1000 area it was recorded as occurring within the Sandy Basin habitat – a habitat type not previously recorded for the Pilgangoora Project. Multiple camera captures were made when cameras were deployed on a fresh burrow complex identified during traverses. Additional signs were recorded but only one active burrow complex was observed.

Whilst not recorded during the P1000 survey, the Northern Quoll is known to occur in the local area and critical habitat has previously been identified in the ridgeline 10 km to the east of the Survey Area. The Survey Area contains habitat that is of value to the Northern Quoll for denning, foraging and dispersal. While all habitats may be utilised at some time, the Granite Dome and Drainage Line habitats are of greatest value. Whilst of value to the Northern Quoll, these habitats are not critical to the survival of the species as described in (CoA 2016), or within 1 km of habitat that is critical to the survival of the Northern Quoll.

The Pilbara leaf-nosed Bat is known to occur in the local area and diurnal roosts occur within the range of the Survey Area. There are no roosts suitable for the Pilbara leaf-nosed Bat in the Survey Area and the species was not recorded during acoustic survey. The conservation ranking of foraging habitat in

the Survey Area is limited to small areas of Priority 4 foraging habitat with the majority being Priority 5. For the majority of the site, the species may occasionally use the habitats for foraging or in transit to other more productive areas.

The Greater Bilby is known to occur in the region, however there are no locally confirmed modern records. Whilst all habitats present in the P1000 area are potentially suitable, no signs or evidence of Bilby were recorded during survey. The species may occasionally use the area for dispersal or foraging but it is unlikely to be an important habitat for the regional population.

The Ghost Bat is known to occur in the local area and diurnal roosts are known to occur within range of the Survey Area. The Survey Area is suitable foraging habitat for the Ghost Bat. The Ghost Bat was not recorded during the acoustic survey, however, the method has limitation with detection of the species. The species is likely to occur within the Survey Area at some time, for foraging purposes only.

The Grey Falcon is known to occur in the local area and the Survey Area is within foraging range of the species. Grey falcon nesting in the Turner River area are likely to visit the Survey Area at some times for the purpose of foraging only.

The Spectacled Hare-wallaby has not previously been confirmed to occur on site in modern times but was historically extant in the area. Signs have been observed during two previous surveys for the Pilgangoora Project that are considered likely to be from this species. No signs were recorded in the P1000 area but the Spinifex Open Plains is potentially suitable for the species, particularly in denser patches of vegetation.

6.6 INTRODUCED FAUNA

Camera survey recorded multiple captures of a cat, inhabiting the same termite mound as was used by the Pilbara Olive Python. Cats are a threatening process for the Pilbara Olive Python (TSSC 2008) and other threatened species in the Pilbara region (DoTE 2015).

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APPENDICES

APPENDIX A: CONSERVATION AND DECLARED CATEGORIES

Conservation categories for threatened species and communities protected under Federal legislation are defined under the *Environment Protection and Biodiversity Conservation Act 1999* and the *Environment Protection and Biodiversity Conservation Regulations 2000* are listed in Tables A.1. and A.2.

Table A.1: Categories and definitions for threatened flora and fauna species listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

Conservation Category	Definition
Extinct	Taxa with no reasonable doubt that the last member of the species has died.
Extinct in the wild	Taxa known to survive only in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriated seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (E)	Taxa are not critically endangered; and are facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (V)	Taxa are not critically endangered or endangered; and are facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation dependent (CD)	Taxa are the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or the following subparagraphs are satisfied: <ul style="list-style-type: none"> i) the taxa is a species of fish; ii) the taxa is the focus of a management plan that provides management actions necessary to stop the decline of, and support the recovery of, the taxa so that its chances of long term survival in nature are maximized; iii) the management plan is in force under a law of the Commonwealth or of a State or Territory; and iv) Cessation of the management plan would adversely affect the conservation status of the taxa. Fish includes all taxa of bony fish, sharks, rays, crustaceans, molluscs and other marine organisms, but does not include marine mammals/reptiles.

Table A.2: Definitions for Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999*.

Conservation Category	Definition
Critically endangered	If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

For Section 182 of the EPBC Act and 179 of the EPBC Act Threatened Ecological Communities and Native species are in the Critically Endangered, Endangered or Vulnerable category if they meet any of the criteria for the category mentioned in Table A.3:

Table A.3: Criteria for listing Threatened Species and Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Regulations 2000*

Threatened Species				
Item	Criterion	Category		
		Critically Endangered	Endangered	Vulnerable
1	It has undergone, is suspected to have undergone, or is likely to undergo in the immediate future:	A very severe reduction in numbers	A severe reduction in numbers	A substantial reduction in numbers
2	Its geographic distribution is precarious for the survival of the species and is:	Very restricted	Restricted	limited
3	The estimated total number of mature individuals is: And: (a) Evidence suggests that the number will continue to decline at: or (b) The number is likely to continue to decline and its geographic distribution is:	Very low	Low	limited
		A very high rate	A high rate	A substantial rate
		Precarious for its survival	Precarious for its survival	Precarious for its survival
4	The estimated total number of mature individuals is:	Extremely low	Very low	low
5	The probability of its extinction in the wild is at least:	50% in the immediate future	20% in the near future	10% in the medium term future
Threatened Ecological Communities				
Item	Criterion	Category		
		Critically Endangered	Endangered	Vulnerable
1	Its decline in geographic distribution is:	Very severe	Severe	substantial
2	Its geographic distribution is: And the nature of its distribution makes it likely that the action of a threatening process could cause it to be lost in:	Very restricted	restricted	limited
		The immediate future	The near future	The medium term future
3	For a population of a native species that is likely to play a major role in the community, there is a: To the extent that restoration of the community is not likely to be possible in:	Very severe decline	Severe decline	Substantial decline
		The immediate future	The near future	The medium term future
4	The reduction in its integrity across most of its geographic distribution is: As indicated by degradation of the community or its habitat, or disruption of important community processes, that is:	Very severe	severe	substantial
		Very severe	severe	substantial
5	The rate of continuing detrimental change is: As indicated by	Very severe	severe	substantial

	(a) A rate of continuing decline in its geographic distribution, or a population of a native species that is believed to play a major role in the community, that is: or	Very severe	severe	serious
	(b) Intensification, across most of its geographic distribution, in degradation, or disruption of important community processes, that is:	Very severe	severe	serious
6	A quantitative analysis shows that its probability of extinction, or extreme degradation over all its geographic distribution, is:	At least 50% in the immediate future	At least 20% in the near future	At least 10% in the medium term future

In Western Australia, the *Biodiversity Conservation Act 2016* (BC Act) provides for the statutory listing of Threatened Ecological Communities, under the categories listed in Table A.4.

Table A.4: Definitions and criteria for Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable Ecological Communities. Department of Environment and Conservation (2013).

PD : Presumed Totally Destroyed
<p>An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.</p> <p>An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B):</p> <p>A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or</p> <p>B) All occurrences recorded within the last 50 years have since been destroyed.</p>
CR : Critically Endangered
<p>An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.</p> <p>An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C):</p> <p>A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii):</p> <ul style="list-style-type: none"> i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. <p>B) Current distribution is limited, and one or more of the following apply (i, ii or iii):</p> <ul style="list-style-type: none"> i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. <p>C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).</p>
En : Endangered
<p>An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.</p> <p>An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C):</p> <p>A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii):</p> <ul style="list-style-type: none"> i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii) modification throughout its range is continuing such that in the short term future (within approximately

20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.
B) Current distribution is limited, and one or more of the following apply (i, ii or iii):
i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);
ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;
iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.
C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

VU : Vulnerable

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

In Western Australia, possible Threatened Ecological Communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5 (Table A.4).

Table A.5: Definitions and criteria for Priority Ecological Communities Department of Environment and Conservation (2013).

<p>P1: Priority One – Poorly-known ecological communities</p> <p>Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤ 5 occurrences or a total area of ≤ 100 ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.</p>
<p>P2: Priority Two – Poorly-known ecological communities</p> <p>Communities that are known from few occurrences with a restricted distribution (generally ≤ 10 occurrences or a total area of ≤ 200 ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.</p>
<p>P3: Priority Three – Poorly-known ecological communities</p> <p>(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.</p>
<p>P4: Priority Four</p> <p>Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.</p> <p>(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.</p>
<p>P5: Priority Five – Conservation dependent ecological communities</p> <p>Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.</p>

In Western Australia, the Wildlife Conservation (Specially Protected Fauna) Notice 2018 and the Wildlife Conservation (Rare Flora) Notice 2018 have been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.

Categories of Threatened, Extinct and Specially Protected fauna and flora are listed in Table A.6.

The definition of flora includes algae, fungi and lichens. The definition of Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

Table A.6: Conservation codes for Western Australian flora and fauna under the *Biodiversity Conservation Act 2016* (DBCA 2019).

Code	Conservation Category	Definition
Threatened species		
Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the Biodiversity Conservation Act 2016 (BC Act). Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for Threatened Fauna. Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the Wildlife Conservation (Rare Flora) Notice 2018 for Threatened Flora. The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.		
CR	Critically Endangered	Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.
EN	Endangered	Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora
VU	Vulnerable	Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for vulnerable fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.
Extinct species		
Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.		

EX	Extinct	<p>Species where “there is no reasonable doubt that the last member of the species has died”, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).</p> <p>Published as presumed extinct under schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for extinct fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for extinct flora.</p>
EW	Extinct in the Wild	<p>Species that “is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form”, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).</p> <p>Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.</p>
Specially protected species		
<p>Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.</p> <p>Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.</p>		
MI	Migratory Species	<p>Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).</p> <p>Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.</p> <p>Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.</p>
CD	Species of special conservation interest (conservation dependent fauna)	<p>Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).</p> <p>Published as conservation dependent fauna under schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.</p>
OS	Other Specially protected species	<p>Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).</p> <p>Published as other specially protected fauna under schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.</p>

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

Table A.7: Priority species under Western Australian *Biodiversity Conservation Act 2016*.

P1: Priority One – Poorly known taxa
Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2: Priority Two – Poorly known taxa
Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3: Priority Three – Poorly known taxa
Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4: Priority Four: Rare, near threatened and other taxa in need of monitoring
<p>((a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.</p> <p>(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.</p> <p>(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.</p>

The management of introduced species in Western Australia is regulated through the *Biosecurity and Agriculture Management Act 2007* (BAM Act). The BAM Act seeks to establish a biosecurity regulatory scheme to prevent serious animal and plant pests from entering the State and becoming established, and to minimise the spread and impact of any that are already present within the State.

The list of declared pests is provided under the BAM Act. Declared animal and plant pests fall into three categories as Gazetted under the *Biosecurity and Agriculture Management Regulations 2013*. These categories are outlined in Table A.7.

Table A.8: Declared pests control categories as gazetted under the *Biosecurity and Agriculture Management Regulations 2013*.

Category	Description
C1 (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

References

Department of Biodiversity Conservation and Attractions (2019) Conservation Codes for Western Australian Flora and Fauna. Last updated 3 January 2019. Accessed 25/04/20.

<https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Conservation%20code%20definitions.pdf>

Department of Environment and Conservation (2013). Definitions, categories and criteria for threatened and priority ecological communities. Accessed 25/04/20

https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/definitions_categories_and_criteria_for_threatened_and_priority_ecological_communities.pdf

APPENDIX B: PMST SEARCH RESULTS



Australian Government

Department of Climate Change, Energy,
the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 27-Dec-2023

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar)	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	13
Listed Migratory Species:	10

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <https://www.dcceew.gov.au/parks-heritage/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	21
Key Ecological Features (Marine):	None
Biologically Important Areas:	1
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species

[[Resource Information](#)]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.

Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat may occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area	In feature area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area	In feature area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area	In feature area
MAMMAL			
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area	In feature area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area	In feature area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area	In feature area

PLANT

Quoya zonalis listed as Pityrodia sp. Marble Bar (G.Woodman & D.Coultas GWDC Opp 4) Pilbara Foxglove [91588]	Endangered (listed as Pityrodia sp. Marble Bar)	Species or species habitat known to occur within area	In buffer area only
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REPTILE

Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Liopholis kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji [83160]	Vulnerable	Species or species habitat may occur within area	In buffer area only

Listed Migratory Species

[[Resource Information](#)]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area

Migratory Terrestrial Species

Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area	In feature area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area	In feature area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area	In feature area

Migratory Wetlands Species

Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
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Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area	In feature area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area	In feature area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area	In feature area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area overfly marine area	In feature area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area overfly marine area	In feature area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area	In feature area

Extra Information

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Hemi Gold Project	2023/09556		Referral Decision	In buffer area only
Lynas Find Project	2023/09471		Assessment	In buffer area only
Controlled action				
Abydos Direct Shipping Ore Project	2012/6345	Controlled Action	Post-Approval	In buffer area only
Additional Rail Infrastructure between Herb Elliott Port Facility and Cloudbreak Mine Site	2010/5513	Controlled Action	Post-Approval	In buffer area only
Development of the Wodgina Direct Shipping Ore Project, Stage 2	2011/5975	Controlled Action	Post-Approval	In buffer area only
Mt Dove Direct Shipping Ore Project	2011/5848	Controlled Action	Post-Approval	In buffer area only
North Star Hematite Project	2012/6530	Controlled Action	Post-Approval	In buffer area only
North Star Magnetite Project	2012/6689	Controlled Action	Post-Approval	In buffer area only
Roy Hill to Port Hedland Rail Line and Associated Infrastructure	2010/5424	Controlled Action	Post-Approval	In buffer area only
Wodgina Direct Shipping Ore Project	2009/5167	Controlled Action	Post-Approval	In buffer area only
Not controlled action				
Development of iron ore resources in eastern Pilbara region.	2004/1562	Not Controlled Action	Completed	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
<u>including port at P</u>				
<u>Expansion of the Talison Minerals Storage Facility, Wodgina Mine</u>	2008/4675	Not Controlled Action	Completed	In buffer area only
<u>Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia</u>	2015/7522	Not Controlled Action	Completed	In feature area
<u>Pilbara Bulk Ore Transport System Project, WA</u>	2016/7637	Not Controlled Action	Completed	In buffer area only
<u>Pilbara Transmission Project, Pilbara, WA</u>	2018/8349	Not Controlled Action	Completed	In buffer area only
<u>Rail and Port Facilities</u>	2001/474	Not Controlled Action	Completed	In buffer area only
<u>Wodgina Lithium Mine Expansion, Pilbara, NT</u>	2018/8194	Not Controlled Action	Completed	In buffer area only
Not controlled action (particular manner)				
<u>Additional Rail Infrastructure</u>	2012/6314	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
<u>Atlas Boodarie Link Project, WA</u>	2012/6506	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
<u>Mine the Hercules Deposit under the Wodgina Direct Shipping Ore Project Stage 3</u>	2013/6789	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
Referral decision				
<u>Mine the Hercules Deposit under the Wodgina Direct Shipping Ore Project ??? Stage 3</u>	2013/6777	Referral Decision	Completed	In buffer area only
Biologically Important Areas				
Scientific Name		Behaviour	Presence	Buffer Status
Seabirds				
<u><i>Ardena pacifica</i></u>				
Wedge-tailed Shearwater [84292]		Breeding	Known to occur	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact us](#) page.

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APPENDIX C: DETAILED FLORA AND VEGETATION SURVEY SITES

Group average

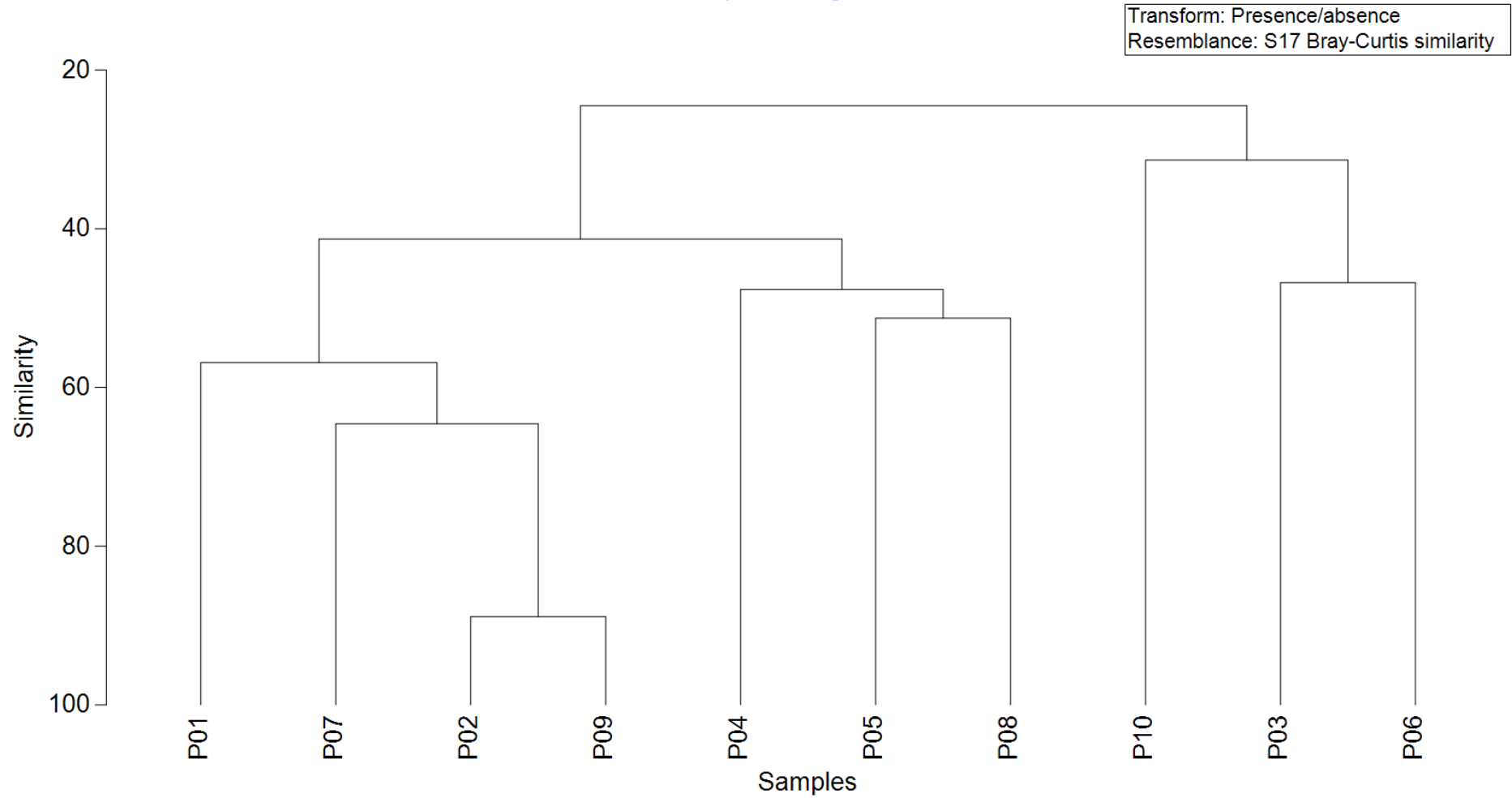


Figure C-1. Dendrogram resulting from the cluster analysis of detailed vegetation sites

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Appendix C

Site: P01: P1000 Camp	WP-NW-(E) 686943	(N) 7672104
Date: 28/07/2023	WP-NE-(E) 686993	(N) 7672109
Botanist: NP and TB	WP-SE-(E) 686997	(N) 7672059
Site Type / Size: Quadrat, 50 x 50 m	WP-SW-(E) 686946	(N) 7672054

NW
N
NE
E

300
330
0
30
60
90

• 50S 686949 7672060 ±8 m ▲ 146 m



P01
Animal Plant Mineral
PIL013
28 Sept 2023, 7:11:07 am

Seasonal Conditions:	Hot and dry	Age Since Last Fire:	> 5 years
Soil Type:	Sandy loam	Soil Colour:	Red
Surface Rocks Size/Shape:	0.1-10 cm, angular	Surface Rock Cover (%):	80
Rock Type:	Granite, quartzite		
Landform	Rocky plain with first order ephemeral stream (width~2m)		
Slope aspect	Very gentle gradient to the east		
Vegetation Description	<i>Triodia</i> tussock grassland with scattered emergent Acacia shrubs and small trees		
Condition	Very good		
Disturbances	Minor grazing		
Strata	Height (m)	Cover (%)	Species
Overstorey	3.5	1	<i>Acacia inaequilatera</i>
Midstorey	2	2	<i>Acacia spp.</i>
Understorey	0.8	70	<i>Triodia spp.</i>
Conservation Significant Flora:			

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Site: P02: P1000 Camp				WP-N-(E) 686503		(N) 7672308		Site: P03: P1000 Camp				WP-NW-(E) 686838		(N) 7672848	
Date: 28/07/2023				WP-E-(E) 686549		(N) 7672289		Date: 28/07/2023				WP-NE-(E) 686937		(N) 7672864	
Botanist: NP and TB				WP-S-(E) 686530		(N) 7672243		Botanist: NP and TB				WP-SE-(E) 686942		(N) 7672840	
Site Type / Size: Quadrat, 50 x 50 m				WP-W-(E) 686483		(N) 7672261		Site Type / Size: Quadrat, 25 x 100 m				WP-SW-(E) 686843		(N) 7672823	
P02				PIL013				P03				PIL013			
Animal Plant Mineral				28 Sept 2023, 8:11:16 am				Animal Plant Mineral				28 Sept 2023, 9:12:04 am			
Seasonal Conditions:		Hot and dry		Age Since Last Fire:		> 5 years		Seasonal Conditions:		Hot and dry		Age Since Last Fire:		> 5 years	
Soil Type:		Loam		Soil Colour:		Red		Soil Type:		Sandy loam		Soil Colour:		Red	
Surface Rocks Size/Shape:		0.1-5 cm, angular		Surface Rock Cover (%):		15		Surface Rocks Size/Shape:		0.1-2 cm, angular		Surface Rock Cover (%):		2	
Rock Type:		Granite, quartzite		Rock Type:		Quartzite, calcrete		Rock Type:		Quartzite, calcrete		Rock Type:		Quartzite, calcrete	
Landform		Flat, stony plain		Landform		Flat		Landform		First order ephemeral drainage line in a sandy plain		Landform		First order ephemeral drainage line in a sandy plain	
Slope aspect		Flat		Slope aspect		Flat		Slope aspect		Flat		Slope aspect		Flat	
Vegetation Description		<i>Triodia</i> tussock grassland with scattered emergent <i>Acacia</i> shrubs		Vegetation Description		Open woodland with dense <i>Acacia</i> spp midstorey, with <i>Triodia</i> hummock grassland on surrounding plains		Vegetation Description		Open woodland with dense <i>Acacia</i> spp midstorey, with <i>Triodia</i> hummock grassland on surrounding plains		Vegetation Description		Open woodland with dense <i>Acacia</i> spp midstorey, with <i>Triodia</i> hummock grassland on surrounding plains	
Condition		Very good		Condition		Very Good		Condition		Very Good		Condition		Very Good	
Disturbances		Minor grazing		Disturbances		Minor grazing		Disturbances		Minor grazing		Disturbances		Minor grazing	
Strata	Height (m)	Cover (%)	Species	Strata	Height (m)	Cover (%)	Species	Strata	Height (m)	Cover (%)	Species	Strata	Height (m)	Cover (%)	Species
Overstorey	3.5	2	<i>Acacia inaequilatera</i>	Overstorey	6	10	<i>Corymbia hamersleyana</i>	Overstorey	6	10	<i>Corymbia hamersleyana</i>	Overstorey	6	10	<i>Corymbia hamersleyana</i>
Midstory	1.6	5	<i>Acacia</i> spp.	Midstory	3.5	20	<i>Acacia</i> spp.	Midstory	3.5	20	<i>Acacia</i> spp.	Midstory	3.5	20	<i>Acacia</i> spp.
Understorey	0.8	60	<i>Triodia</i> spp.	Understorey	0.7	40	<i>Triodia</i> spp.	Understorey	0.7	40	<i>Triodia</i> spp.	Understorey	0.7	40	<i>Triodia</i> spp.
Conservation Significant Flora				Conservation Significant Flora:				Conservation Significant Flora:				Conservation Significant Flora:			

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Site: P04: P1000 Camp				WP-NW-(E) 687089		(N) 7673997		Site: P05: P1000 Camp				WP-N-(E) 686077		(N) 7674488	
Date: 28/07/2023				WP-NE-(E) 687139		(N) 7673997		Date: 28/07/2023				WP-E-(E) 686101		(N) 7674444	
Botanist: NP and TB				WP-SE-(E) 687144		(N) 7673948		Botanist: NP and TB				WP-S-(E) 686059		(N) 7674423	
Site Type / Size: Quadrat, 50 x 50 m				WP-SW-(E) 687095		(N) 7673947		Site Type / Size: Quadrat, 50 x 50 m				WP-W-(E) 686033		(N) 7674465	
P04 Animal Plant Mineral				PIL013 28 Sept 2023, 10:48:08 am				P05 Animal Plant Mineral				PIL013 28 Sept 2023, 11:48:04 am			
Seasonal Conditions:		Hot and dry		Age Since Last Fire:		2 years		Seasonal Conditions:		Hot and dry		Age Since Last Fire:		> 5 years	
Soil Type:		Loamy sand		Soil Colour:		Orange		Soil Type:		Loam		Soil Colour:		Red	
Surface Rocks Size/Shape:		0.1-5 cm, angular		Surface Rock Cover (%):		10		Surface Rocks Size/Shape:		0.1-2 cm, angular		Surface Rock Cover (%):		55	
Rock Type:		Granite, quartzite		Rock Type:		Quartzite, granite		Landform		Stony flat plain		Slope aspect		Flat	
Landform		Flat, sandy and rocky plain. Some granite base rock surface expression.		Vegetation Description		<i>Triodia</i> tussock grassland with scattered emergent trees and shrubs.		Vegetation Description		<i>Triodia</i> hummock grassland with scattered emergent trees and shrubs.		Condition		Very Good	
Slope aspect		Flat		Condition		Very Good		Disturbances		Some cattle grazing.		Disturbances		Minor grazing occasional tracks	
Vegetation Description		<i>Triodia</i> tussock grassland with scattered emergent trees and shrubs.		Strata				Strata				Strata			
Condition		Very Good		Height (m)		4		Height (m)		4		Height (m)		4	
Disturbances		Some cattle grazing.		Cover (%)		0.5		Cover (%)		2		Cover (%)		2	
Strata				Species		<i>Corymbia hamersleyana</i>		Species		<i>Corymbia hamersleyana</i>		Species		<i>Corymbia hamersleyana</i>	
Overstorey		4		Overstorey		4		Overstorey		4		Overstorey		4	
Midstorey		2.5		Midstorey		2.5		Midstorey		2.5		Midstorey		2.5	
Understorey		0.6		Understorey		0.6		Understorey		0.6		Understorey		0.6	
Conservation Significant Flora:				Conservation Significant Flora:		<i>Triodia chichesterensis</i> (P3), <i>Euploca mutica</i> (P3)		Conservation Significant Flora:		<i>Triodia chichesterensis</i> (P3), <i>Euploca mutica</i> (P3)		Conservation Significant Flora:		<i>Triodia chichesterensis</i> (P3), <i>Euploca mutica</i> (P3)	

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Site: P06: P1000 Camp				WP-NW-(E) 688580		(N) 7671631		Site: P07: P1000 Camp				WP-NW-(E) 688367		(N) 7672976									
Date: 28/07/2023				WP-NE-(E) 688630		(N) 7671630		Date: 28/07/2023				WP-NE-(E) 688418		(N) 7672981									
Botanist: NP and TB				WP-SE-(E) 688632		(N) 7671581		Botanist: NP and TB				WP-SE-(E) 688429		(N) 7672933									
Site Type / Size: Quadrat, 50 x 50 m				WP-SW-(E) 688585		(N) 7671580		Site Type / Size: Quadrat, 50 x 50 m				WP-SW-(E) 688379		(N) 7672928									
P06				PIL013				P07				PIL013											
Animal Plant Mineral				28 Sept 2023, 2:55:14 pm				Animal Plant Mineral				28 Sept 2023, 3:51:39 pm											
Seasonal Conditions:				Hot and dry		Age Since Last Fire:		> 5 years		Seasonal Conditions:				Hot and dry		Age Since Last Fire:		> 5 years					
Soil Type:				Sand		Soil Colour:		Red		Soil Type:				Loamy sand		Soil Colour:		Red					
Surface Rocks Size/Shape:				0.1-5cm, angular		Surface Rock Cover (%):		10		Surface Rocks Size/Shape:				0.1-5 cm, angular		Surface Rock Cover (%):		10					
Rock Type:				Quartzite, granite, ironstone								Rock Type:				Granite, quartzite							
Landform				Small ephemeral creekline and surrounding riparian banks								Landform				Flat sandy and stony plain							
Slope aspect				Stream flow to the west								Slope aspect				Flat							
Vegetation Description				Riparian woodland with <i>Acacia</i> spp. midstorey and mixed grass understorey.								Vegetation Description				<i>Triodia</i> hummock grassland with occasional emergent trees and shrubs.							
Condition				Good								Condition				Very Good							
Disturbances				Heavy cattle grazing on riparian bank, weedy <i>Cenchrus</i> spp. grasses and occasional tracks								Disturbances				Minor grazing							
Strata		Height (m)		Cover (%)		Species						Strata		Height (m)		Cover (%)		Species					
Overstorey		6.5		5		<i>Eucalyptus victrix</i>						Overstorey		4		2		<i>Corymbia zygophylla</i>					
Midstory		2.5		10		<i>Acacia</i> spp.						Midstory		1.8		5		<i>Acacia</i> spp.					
Understorey		0.6		30		<i>Triodia</i> spp.						Understorey		0.6		45		<i>Triodia lanigera</i>					
Conservation Significant Flora:																							

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Appendix C

Site: P08: P1000 Camp				Site: P09: P1000 Camp			
Date: 30/07/2023				Date: 30/07/2023			
Botanist: NP and TB				Botanist: NP and TB			
Site Type / Size: Quadrat, 50 x 50 m				Site Type / Size: Quadrat, 50 x 50 m			
WP-N-(E) 685948		(N) 7673763		WP-NW-(E) 688211		(N) 7673626	
WP-E-(E) 685994		(N) 7673742		WP-NE-(E) 688261		(N) 7673628	
WP-S-(E) 685971		(N) 7673696		WP-SE-(E) 688260		(N) 7673578	
WP-W-(E) 685926		(N) 7673717		WP-SW-(E) 688210		(N) 7673578	
<p>50S 685933 7673723 ±7 m ▲ 146 m</p>				<p>50S 688218 7673627 ±8 m ▲ 154 m</p>			
<p>P08 Animal Plant Mineral 30 Sept 2023, 6:50:47 am PIL013</p>				<p>P09 Animal Plant Mineral 30 Sept 2023, 8:12:04 am PIL013</p>			
Seasonal Conditions:		Hot and dry		Seasonal Conditions:		Hot and dry	
Soil Type:		Sand		Soil Type:		Loamy sand	
Surface Rocks Size/Shape:		0.1-5 cm		Surface Rocks Size/Shape:		0.1-2 cm, angular	
Rock Type:		Granite, quartzite		Rock Type:		Quartzite, granite	
Landform		Edge of granite dome outcrop with undulating sandy plain		Landform		Flat, sandy plain	
Slope aspect		Slight gradient to NW		Slope aspect		Flat	
Vegetation Description		<i>Triodia</i> hummock grassland with occasional emergent tall shrubs.		Vegetation Description		<i>Triodia</i> hummock grassland with scattered emergent trees and shrubs.	
Condition		Very Good		Condition		Very Good	
Disturbances		Minor grazing, occasional tracks		Disturbances		Minor grazing	
Strata	Height (m)	Cover (%)	Species	Strata	Height (m)	Cover (%)	Species
Overstorey	3	2	<i>Acacia inaequilatera</i>	Overstorey	4	1	<i>Acacia inaequilatera</i>
Midstorey				Midstorey	1.8	2	<i>Acacia spp.</i>
Understorey	0.6	40	<i>Triodia spp.</i>	Understorey	0.6	60	<i>Triodia spp.</i>
Conservation Significant Flora: <i>Euploca mutica</i> (P3)				Conservation Significant Flora:			

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Site: P10: P1000 Camp	WP-N-(E) 688252	(N) 7672242
Date: 30/07/2023	WP-E-(E) 688297	(N) 7672225
Botanist: NP and TB	WP-S-(E) 688283	(N) 7672177
Site Type / Size: Quadrat, 50 x 50 m	WP-W-(E) 688236	(N) 7672195

S
180
SW
210
W
270
NW
330

● 50S 688295 7672218 ±14 m ▲ 147 m



P10
Animal Plant Mineral
PIL013
30 Sept 2023, 8:57:01 am

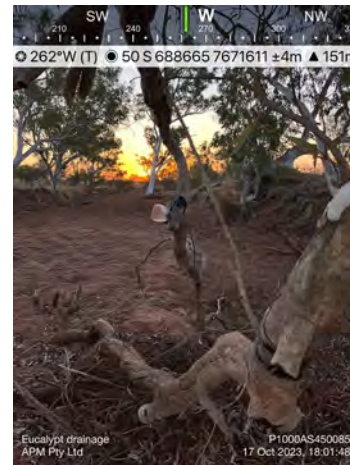
Seasonal Conditions:	Hot and dry	Age Since Last Fire:	> 5 years
Soil Type:	Sand	Soil Colour:	Red
Surface Rocks Size/Shape:	N/A	Surface Rock Cover (%):	None
Rock Type:	N/A		
Landform	Low lying sandy basin within an undulating sandy plain (moisture gaining area)		
Slope aspect	Flat		
Vegetation Description	<i>Triodia</i> hummock grassland with scattered emergent trees		
Condition	Very Good		
Disturbances	Minor grazing		
Strata	Height (m)	Cover (%)	Species
Overstorey	3.5	0.5	<i>Acacia inaequilatera</i>
Midstorey			
Understorey	0.4	50	<i>Triodia secunda</i> , <i>Triodia epactia</i>
Conservation Significant Flora:			

APPENDIX D: FAUNA SURVEY PHOTOS

Motion Cameras and Anabat acoustic bat sensor locations

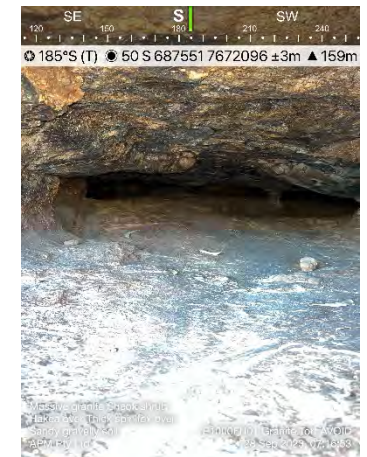
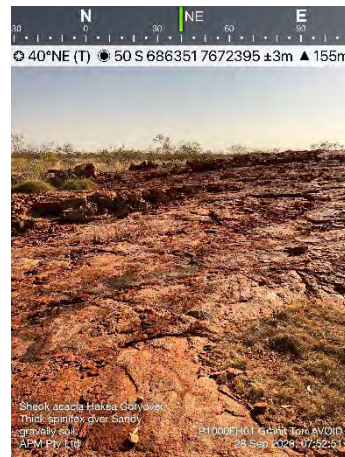
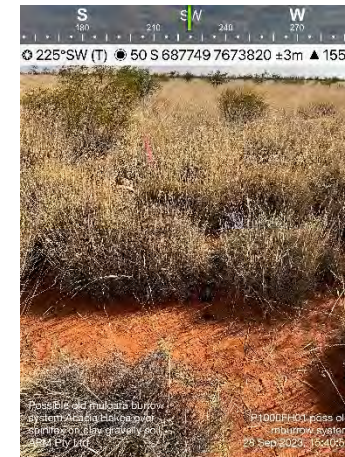


Anabat Acoustic Bat Detector locations

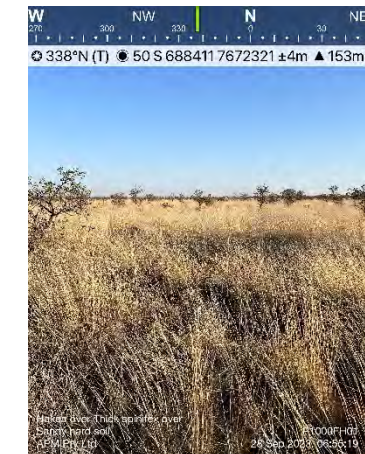
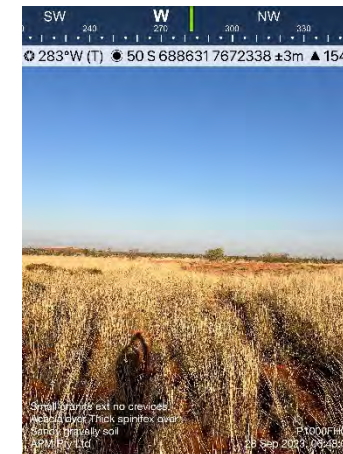
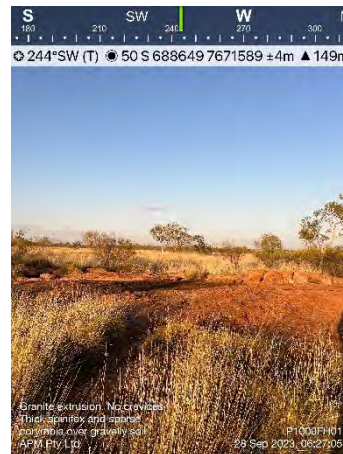
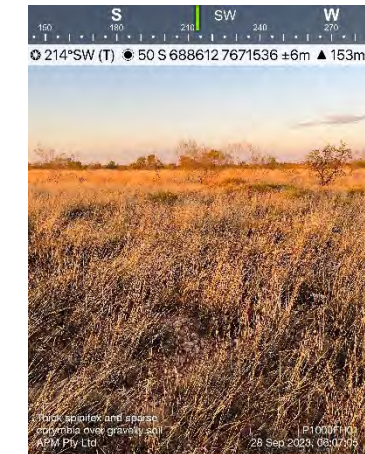
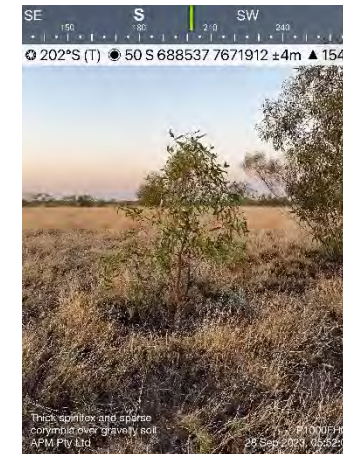
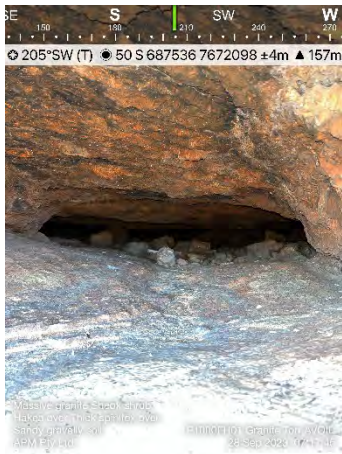


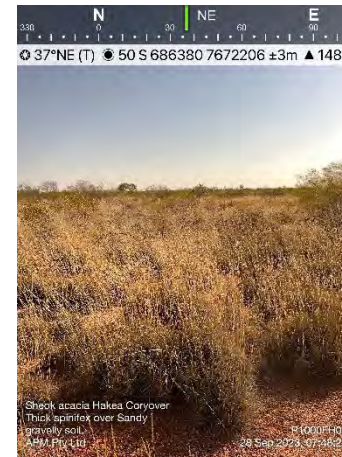
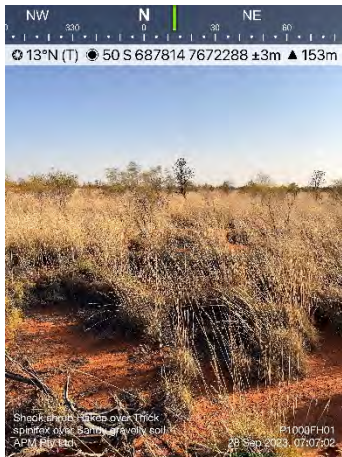
Conservation Significant Fauna Signs

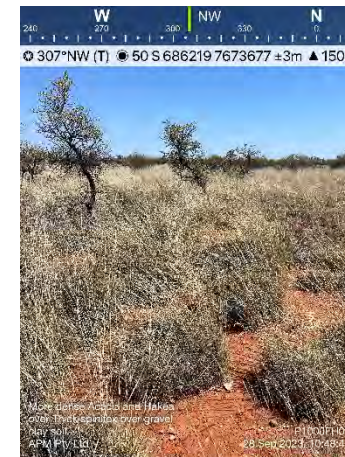
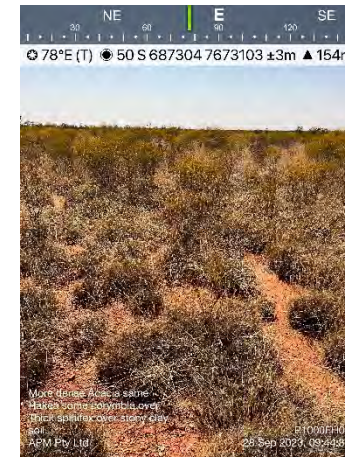
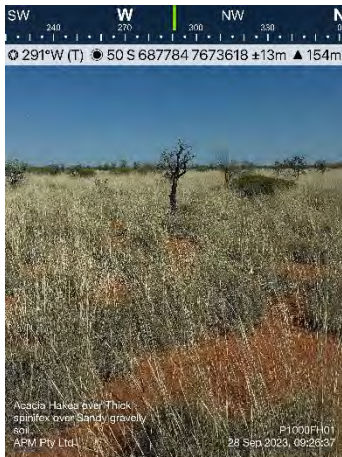


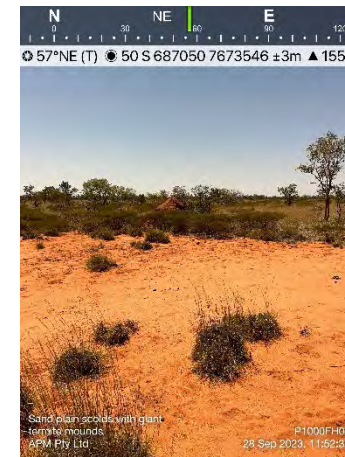
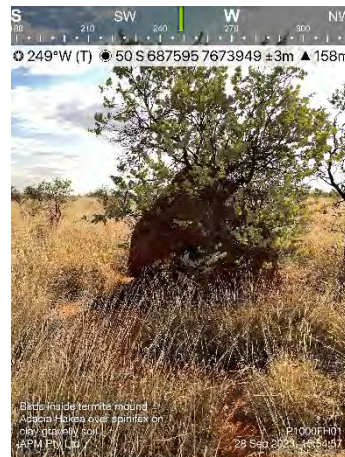


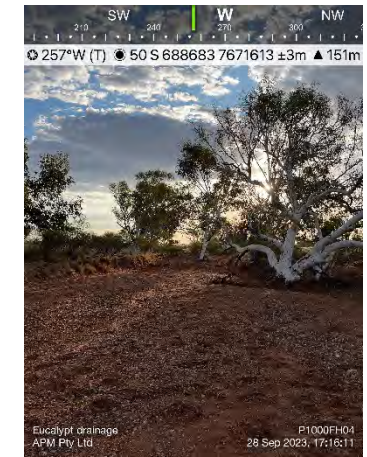
Fauna Habitat Assessment Sites and Reference Locations











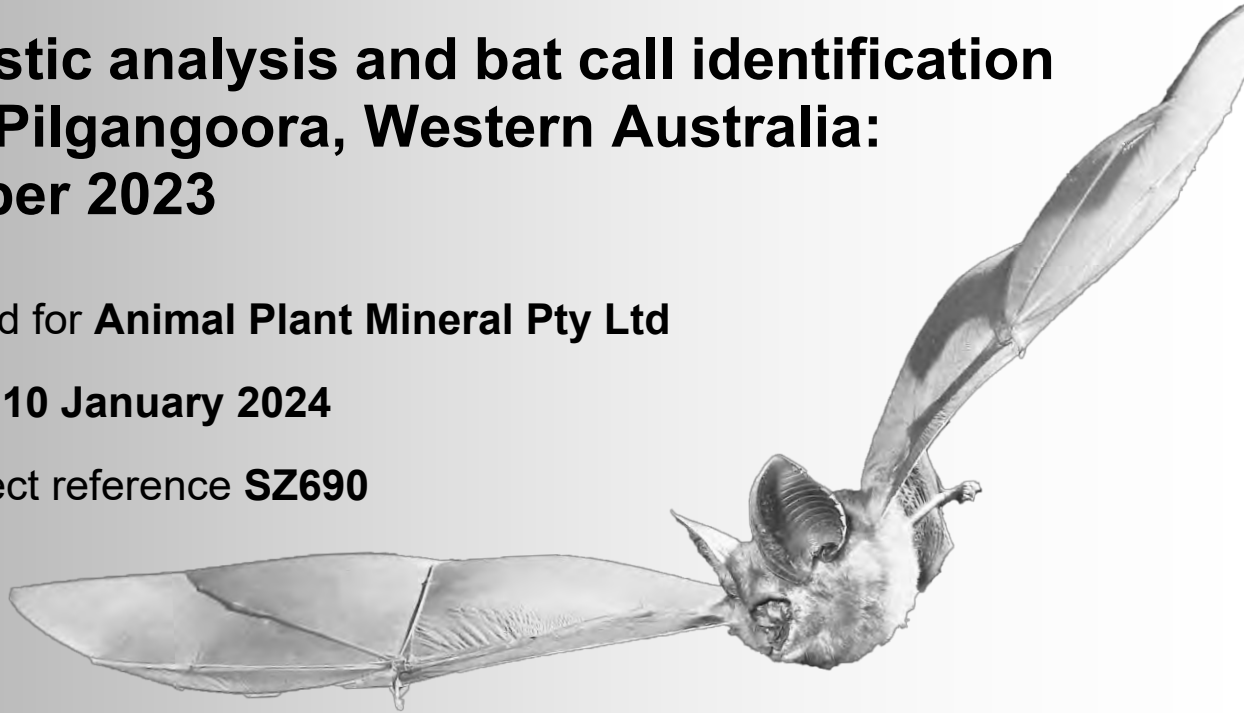
APPENDIX E: ACOUSTIC ANALYSIS AND BAT CALL IDENTIFICATION – SPECIALISED ZOOLOGICAL

Acoustic analysis and bat call identification from Pilgangoora, Western Australia: October 2023

Prepared for **Animal Plant Mineral Pty Ltd**

Version **10 January 2024**

SZ project reference **SZ690**



Prepared by **Dr Kyle Armstrong and Yuki Konishi**

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This report should be included as an appendix in any larger submission to Government, and cited as:

Specialised Zoological (2024). Acoustic analysis and bat call identification from Pilgangoora, Western Australia: October 2023. Unpublished report by Specialised Zoological for Animal Plant Mineral Pty Ltd, 10 January 2024, project reference SZ690.

Summary

The outcome is provided of the analysis of acoustic (bat detector) recordings made in October 2023 in the Pilgangoora project area, located in the Pilbara region of Western Australia.

The scope of the analysis was limited to the detection of the Threatened-listed Ghost Bat *Macroderma gigas* (Megadermatidae) and Pilbara Leaf-nosed Bat *Rhinonycteris aurantia* (Rhinonycteridae).

The recording dataset comprised a total of 52 recording nights from four bat detector units placed at four recording sites (**Table 1**).

Acoustic processing of the bat detector recordings was conducted separately for each of the two target bat species using methods optimised for the detection of their unique echolocation call types.

A total of 25 echolocation call sequences of the Pilbara Leaf-nosed Bat was detected at three separate recording sites (**Table 2; Figure 1**).

The detection of echolocation call sequences well after sunset and well before sunrise, and away from areas of rocky outcrop containing deep caves, is indicative of individuals of this species out foraging away from a diurnal roost.

No calls of the Ghost Bat were observed in the recordings.

Further information is available should verification be required.

Methods

The data provided were recorded in full spectrum WAV format with Titley Scientific Anabat Swift bat detectors (sampling rate 500 kHz, set to record between sunset and sunrise).

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong et al. 2021a,b) was applied to the recordings made on the survey. Firstly, the WAV files were scanned in the software SCAN'R version 1.8.3 (Binary Acoustic Technology) for bat echolocation calls using a parameter set optimised for the detection of each of the two target species. This process provides measurements (SCAN'R parameters) from each putative pulse of the target species. The outputs were then used to determine if putative bat pulses measured in SCAN'R could be attributed to the two target species. This was done in two ways.

First, all WAV files containing putative calls of the Pilbara Leaf-nosed Bat were inspected in Adobe Audition version 23.1 software, and listings of files containing false positive identifications were discarded. Custom R language scripts assisted with summarisation of the remaining data, and the calculation of times of first detection after sunset and last detection before sunrise.

Second, a custom [R] language 'shiny' app was used to aid recognition of the calls of the Ghost Bat. The app assisted with three tasks:

1. Performed a Discriminant Function Analysis on training data from representative calls from cave-roosting bats in the Pilbara;
2. From the measurements of each putative Ghost Bat echolocation pulse from SCAN'R, calculated values for the first two Discriminant Functions that could separate the signal types derived from the analysis of training data, and plotted these resulting coordinates over confidence regions for the defined signal types; and
3. Facilitated an inspection in a spectrogram of chosen examples of interest (within the confidence region for Ghost Bat calls) for each recording night by opening the original WAV files in Adobe Audition version 23.1.

Species were identified based on information in Armstrong and Coles (2007) and the author's own unpublished material.

Limitations

The identifications presented in this report have been made within the following context:

1. The identifications made herein were based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to providing information on the identification of two target bat species in bulk ultrasonic recordings. Further comment on these species and the possible impacts of a planned project on bat species were not part of the scope.
3. In the case of the present report, the recording equipment was set up and supplied by Specialised Zoological. The equipment was operated by the third party on the survey.
4. Specialised Zoological has not made a visit to observe the habitats available for bats, nor have we visited the specific project areas on a previous occasion.
5. Specialised Zoological has had no input into the overall design and timing of this bat survey, recording site placement, nor the degree of recording site replication.
6. While Specialised Zoological has made identifications to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.
8. The most reliable way of detecting the Ghost Bat with bat detectors is to place the equipment with the microphone facing into a potential cave roosting site. The echolocation calls of this species are of low amplitude, and therefore most detectable when a Ghost Bat flies close to the bat detector as it exits the underground structure. If there is uncertainty about whether Ghost Bats are present in a cave, then video recordings can be a useful addition to the survey. The detection of Ghost Bats with bat detectors away from cave entrances is less reliable, unless an approach based on an acoustic lure is used (e.g. see the new method described in papers accepted recently by Ruykys et al. 2023 and Hanrahan et al. 2023).
9. This version of the document supersedes any previous version. Previous drafts are not authorised by us for submission to the regulator or the public domain.

References

- Armstrong, K.N. and Coles, R.B. (2007). Echolocation call frequency differences between geographic isolates of *Rhinonictoris aurantia* (Chiroptera: Hipposideridae): implications of nasal chamber size. *Journal of Mammalogy* 88: 94–104.
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<https://doi.org/10.1071/ZO20044>
- Armstrong K.N., Clarke S., Linke A., Scanlon A., Roetman P., Hitch, A.T. and Donnellan S.C. (2021b). Citizen science implements the first intensive acoustics-based survey of insectivorous bat species across the Murray-Darling Basin of South Australia. *Australian Journal of Zoology* 68: 364–381. <https://doi.org/10.1071/ZO20051>
- Hanrahan, N., Turbill C., Armstrong K.N., Dalziell A.H. and Welbergen J.A. (2023 in press). Calling up ghosts: acoustic playback of social vocalisations reveals complex communication in a cryptic bat and provides a promising tool for monitoring disturbance-sensitive species. *Mammal Research*.
<https://doi.org/10.1007/s13364-023-00727-w>
- Ruykys, L., Hanrahan, N. and Stokeld, D. (2023). Novel acoustic lure methodology facilitates detection of the cryptic ghost bat at a landscape scale. *Wildlife Research*.
<https://doi.org/10.1071/WR22189>

Table 1. Summary of bat detector recordings analysed. [Ra: number of echolocation sequences of the Pilbara Leaf-nosed Bat *Rhinonictoris aurantia*]

Swift Serial No.	Latitude	Longitude	No. recording nights	Nights of	Ra calls
450007	-21.12085	118.70488	13	2023-10-20 – 2023-11-01	8
450085	-21.04674	118.81572	13	2023-10-20 – 2023-11-01	0
497962	-21.10189	118.88993	13	2023-10-20 – 2023-11-01	3
622904	-21.10173	118.88828	13	2023-10-20 – 2023-11-01	14
Totals			52	2023-10-20 – 2023-11-01	25

Table 2. Summary of detections of the Pilbara Leaf-nosed Bat (alternating blue highlight distinguishes different sites).

Site-unit	Night of	Passes	Sunset	Dusk	Dawn	Sunrise	Time of first detection	Time of last detection	Time since sunset	Time until sunrise
450007	20/10/2023	1	20/10/2023 18:10	20/10/2023 18:32	21/10/2023 5:08	21/10/2023 5:30	1:15:12	1:15:12	7H 5M 4S	4H 15M 32S
450007	21/10/2023	1	21/10/2023 18:10	21/10/2023 18:33	22/10/2023 5:07	22/10/2023 5:30	1:50:00	1:50:00	7H 39M 28S	3H 40M 0S
450007	22/10/2023	3	22/10/2023 18:10	22/10/2023 18:33	23/10/2023 5:06	23/10/2023 5:29	20:37:15	3:28:07	2H 26M 18S	2H 1M 10S
450007	23/10/2023	1	23/10/2023 18:11	23/10/2023 18:34	24/10/2023 5:05	24/10/2023 5:28	3:49:31	3:49:31	9H 38M 8S	1H 39M 3S
450007	24/10/2023	1	24/10/2023 18:11	24/10/2023 18:34	25/10/2023 5:05	25/10/2023 5:27	1:01:17	1:01:17	6H 49M 28S	4H 26M 36S
450007	26/10/2023	1	26/10/2023 18:12	26/10/2023 18:35	27/10/2023 5:03	27/10/2023 5:26	20:03:46	20:03:46	1H 51M 4S	9H 22M 47S
497962	20/10/2023	1	20/10/2023 18:10	20/10/2023 18:32	21/10/2023 5:08	21/10/2023 5:30	21:11:28	21:11:28	3H 1M 20S	8H 19M 16S
497962	31/10/2023	1	31/10/2023 18:15	31/10/2023 18:38	1/11/2023 5:00	1/11/2023 5:23	23:08:30	23:08:30	4H 53M 23S	6H 15M 1S
497962	1/11/2023	1	1/11/2023 18:15	1/11/2023 18:38	2/11/2023 4:59	2/11/2023 5:22	23:12:50	23:12:50	4H 57M 13S	6H 10M 8S
622904	20/10/2023	4	20/10/2023 18:10	20/10/2023 18:32	21/10/2023 5:08	21/10/2023 5:30	21:49:05	3:23:38	3H 38M 57S	2H 7M 6S
622904	21/10/2023	2	21/10/2023 18:10	21/10/2023 18:33	22/10/2023 5:07	22/10/2023 5:30	22:15:15	23:07:23	4H 4M 43S	6H 22M 37S
622904	22/10/2023	1	22/10/2023 18:10	22/10/2023 18:33	23/10/2023 5:06	23/10/2023 5:29	3:02:28	3:02:28	8H 51M 31S	2H 26M 49S
622904	23/10/2023	3	23/10/2023 18:11	23/10/2023 18:34	24/10/2023 5:05	24/10/2023 5:28	2:24:16	2:53:40	8H 12M 53S	2H 34M 54S
622904	26/10/2023	1	26/10/2023 18:12	26/10/2023 18:35	27/10/2023 5:03	27/10/2023 5:26	2:39:09	2:39:09	8H 26M 27S	2H 47M 24S
622904	28/10/2023	1	28/10/2023 18:13	28/10/2023 18:36	29/10/2023 5:02	29/10/2023 5:25	1:30:35	1:30:35	7H 16M 57S	3H 54M 42S
622904	31/10/2023	1	31/10/2023 18:15	31/10/2023 18:38	1/11/2023 5:00	1/11/2023 5:23	20:59:01	20:59:01	2H 43M 54S	8H 24M 30S
622904	1/11/2023	1	1/11/2023 18:15	1/11/2023 18:38	2/11/2023 4:59	2/11/2023 5:22	20:08:24	20:08:24	1H 52M 47S	9H 14M 34S

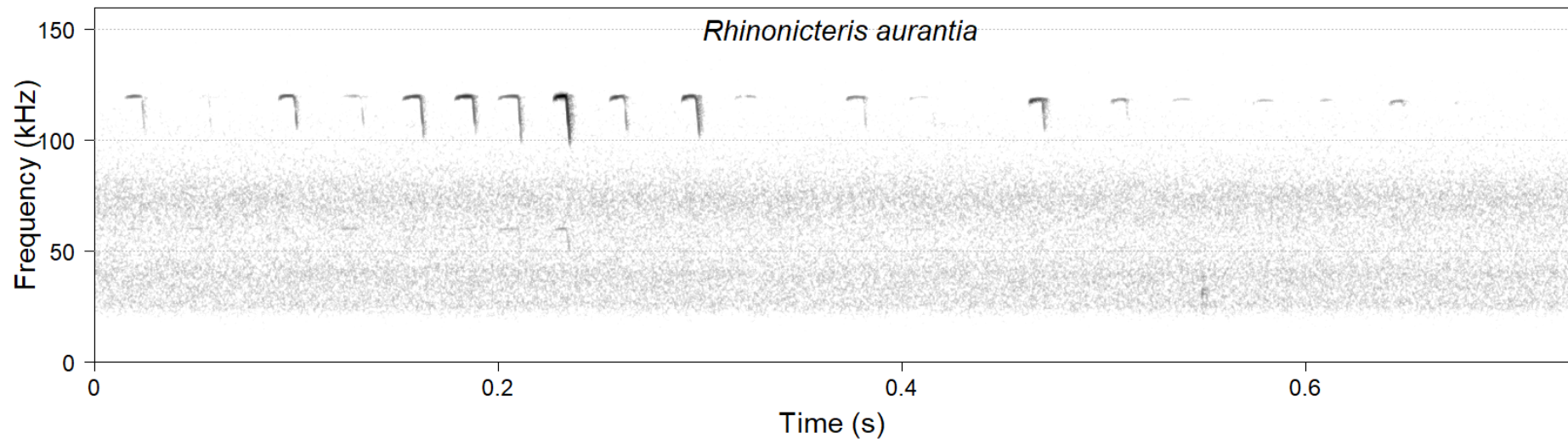


Figure 1. Example echolocation call sequence of the Pilbara Leaf-nosed Bat.

APPENDIX F: SPECIES BY SITE MATRIX - FLORA

P1000 Biological Survey - Pilgangoora Project

Appendix F

Family	Species	Status	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	Op Coll
Amaranthaceae	<i>Alternanthera nana</i>							0.1					
Amaranthaceae	<i>Gomphrena leptoclada</i>									0.1			
Amaranthaceae	<i>Ptilotus astrolasius</i>						0.1			0.1			
Amaranthaceae	<i>Ptilotus calostachyus</i>		0.1				0.1		0.1				
Amaranthaceae	<i>Ptilotus incanus</i>		0.1										
Asteraceae	<i>Pluchea dentex</i>									0.1			
Asteraceae	<i>Pluchea ferdinandi-muelleri</i>		0.1										
Asteraceae	<i>Pluchea tetranthera</i>		0.5		1			2				0.1	
Asteraceae	<i>Pterocaulon sphacelatum</i>									0.1			
Boraginaceae	<i>Euploca mutica</i>	Priority 3					0.1			0.1			
Convolvulaceae	<i>Bonamia erecta</i>			0.1		0.1	0.1	0.1	0.1	0.1	0.1		
Cucurbitaceae	<i>Cucumis argenteus</i>									0.1			
Cyperaceae	<i>Cyperus vaginatus</i>							0.1					
Cyperaceae	<i>Fimbristylis dichotoma</i>		0.1	0.1						0.1	0.1	0.1	
Euphorbiaceae	<i>Euphorbia careyi</i>							0.1		0.1			
Fabaceae	<i>Acacia acradenia</i>				0.5		0.5						
Fabaceae	<i>Acacia adsurgens</i>		0.1	2		0.1	0.5		1	0.5	0.5		
Fabaceae	<i>Acacia bivenosa</i>				0.5			5					
Fabaceae	<i>Acacia holosericea</i>												x
Fabaceae	<i>Acacia inaequilatera</i>		0.5	2	0.5	0.5	0.5		0.5	1	1	0.5	
Fabaceae	<i>Acacia maitlandii</i>		0.5	2		0.5				0.1	1		
Fabaceae	<i>Acacia orthocarpa</i>		0.5										
Fabaceae	<i>Acacia stellaticeps</i>		0.5	2				2	4		0.5	0.1	
Fabaceae	<i>Acacia trachycarpa</i>							5					
Fabaceae	<i>Cajanus cinereus</i>				0.1	0.1		0.1		0.1			
Fabaceae	<i>Crotalaria dissitiflora</i>						0.1			0.1			
Fabaceae	<i>Indigofera hirsuta</i>				0.1								
Fabaceae	<i>Indigofera monophylla</i>		0.1	0.1	0.1		0.1	0.1		0.1	0.1		
Fabaceae	<i>Indigofera rugosa</i>				0.1								
Fabaceae	<i>Rhynchosia minima</i>				0.1			0.1					
Fabaceae	<i>Senna artemisioides</i>					0.1							

P1000 Biological Survey - Pilgangoora Project

Appendix F

Fabaceae	<i>Senna glutinosa</i>		0.1	0.5	0.1		0.1		0.1				
Fabaceae	<i>Senna notabilis</i>							0.1					
Goodeniaceae	<i>Goodenia microptera</i>							0.1					
Lauraceae	<i>Cassytha filiformis</i>				0.1	0.1	0.1			0.1			
Malvaceae	<i>Corchorus incanus</i>				0.1		0.1	0.1		0.1			
Malvaceae	<i>Hibiscus austrinus</i>							0.1					
Malvaceae	<i>Hibiscus sturtii</i>					0.1							
Molluginaceae	<i>Trigastrotheca molluginea</i>				0.1	0.1				0.1			
Myrtaceae	<i>Corymbia hamersleyana</i>		0.5		10	0.5	2						
Myrtaceae	<i>Corymbia zygophylla</i>								2				
Myrtaceae	<i>Eucalyptus victrix</i>							5					
Poaceae	<i>Cenchrus ciliaris</i>	Introduced						0.5					
Poaceae	<i>Cenchrus setiger</i>	Introduced			0.5			0.5					
Poaceae	<i>Chrysopogon fallax</i>				0.1	0.1		0.1					
Poaceae	<i>Dichanthium fecundum</i>							0.5					
Poaceae	<i>Eragrostis elongata</i>							0.1					
Poaceae	<i>Eriachne ciliata</i>								0.1		0.1		
Poaceae	<i>Heteropogon contortus</i>							2					
Poaceae	<i>Paspalidium clementii</i>								0.1				
Poaceae	<i>Sorghum plumosum</i>							0.1					
Poaceae	<i>Sporobolus actinocladius</i>										0.1		
Poaceae	<i>Sporobolus australasicus</i>							0.1					
Poaceae	<i>Themeda triandra</i>							2					
Poaceae	<i>Triodia chichesterensis</i>	Priority 3											X
Poaceae	<i>Triodia epactia</i>		10		10	5		30		15		5	
Poaceae	<i>Triodia lanigera</i>		60	60		45	25		45	25	60		
Poaceae	<i>Triodia secunda</i>				5			2				45	
Poaceae	<i>Triodia wiseana</i>				35		35	0.1				0.1	
Proteaceae	<i>Grevillea pyramidalis</i>					0.5	0.5						
Proteaceae	<i>Grevillea wickhamii</i>		0.5							0.1			
Proteaceae	<i>Hakea lorea</i> subsp. <i>lorea</i>		0.1	0.1									

APPENDIX G: FAUNA LIKELIHOOD OF OCCURRENCE ASSESSMENT

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
-- Birds --					
<i>Actitis hypoleucos</i>	Common Sandpiper	MI	MI	<p>Edge of sheltered waters salt or fresh (<i>e.g.</i> estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations where low perches are available (Johnstone and Storr, 1998).</p> <p>Shallow, pebbly, muddy or sandy edges of rivers and streams coastal to far inland; dams, lakes, sewage ponds; margins of tidal rivers, waterways in mangroves or saltmarshes; mudflats: rocky or sand beaches; causeways, riverside lawns, drains, street gutters (Pizzey and Knight, 2012).</p>	<p>Unlikely. Perching opportunities available in the creeks however sandy substrates indicate water pooling is limited and ephemeral.</p> <p>Two records 8.5 km to the west from a semi-permanent pool in a tributary of the Turner River.</p>
<i>Apus pacificus</i>	Fork-tailed Swift	MI	MI	<p>Broadly distributed aerial species that is not specifically limited to any particular habitat type.</p> <p>Aerial: over open country, from semi-arid deserts to coasts, islands; sometimes over forests, cities (Pizzey and Knight, 2012).</p> <p>Occurs over dry or open habitats comprising of riparian woodland, low scrub, heathland, or saltmarsh, also grasslands and sandplains with spinifex (Morcombe, 2011).</p>	<p>Possible.</p> <p>Listed by the PMST as Likely to occur. Seven records are reported from 1998 – 2014 over a wide variety of habitats.</p> <p>This species is distributed across Australia. It is an aerial species that rarely comes to land. Individuals would not be specifically dependant on any habitats present in the Survey Area.</p>

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	MI	MI	<p>Scarce to moderately common, much more plentiful near coasts than in interior (Johnstone and Storr, 1998).</p> <p>Tidal mudflats, saltmarshes, mangroves; shallow fresh, brackish or saline inland wetlands; floodwaters, irrigated pastures and crops; sewage ponds, saltfields. Widespread summer migrant to coastal and inland Australia (Pizzey and Knight, 2012).</p>	<p>Unlikely. Sandy substrates indicate limited pooling of water in the ephemeral drainage lines and run-on areas. No Permanent pools.</p> <p>No records in the local area. PMST considers the species May occur.</p>
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR	CR, MI	<p>Mainly shallows of estuaries and near-coastal saltlakes (including saltwork ponds) and drying near-coastal freshwater lakes and swamps. Also beaches and near-coastal sewage ponds (Johnstone and Storr, 1998).</p> <p>Tidal mudflats; saltmarsh, saltfields; fresh, brackish or saline wetlands; sewage ponds (Pizzey and Knight, 2012).</p>	<p>Unlikely. Sandy substrates indicate limited pooling of water in the ephemeral drainage lines and run-on areas. No Permanent pools.</p> <p>No records in the local area. PMST considers the species May occur.</p>
<i>Calidris melanotos</i>	Pectoral Sandpiper		MI	<p>Mainly fresh waters (swamps, lagoons, river pools, irrigation channels and sewage ponds); also, samphire flats around estuaries and saltlakes (Johnstone and Storr, 1998).</p> <p>Shallow fresh waters, often with low grass or other herbage; swamp margins, flooded pastures, sewage ponds, occasionally tidal areas, saltmarshes (Pizzey and Knight, 2012).</p>	<p>Unlikely. Sandy substrates indicate limited pooling of water in the ephemeral drainage lines and run-on areas. No Permanent pools.</p> <p>No records in the local area. PMST considers the species May occur.</p>

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
<i>Charadrius veredus</i>	Oriental Plover	MI	MI	Open plains; bare, rolling country, often far from water; ploughed land; muddy or sandy wastes near inland swamps or tidal mudflats; bare claypans; margins of coastal marshes; grassy fields and lawns (Pizzey and Knight, 2012).	Possible. Sandy substrates indicate limited pooling of water in the ephemeral drainage lines and run-on areas. No Permanent pools. One local historic record from an area that is now cleared.
<i>Erythrotriorchis radiatus</i>	Red Goshawk	VU	VU	Well-wooded country (Johnstone and Storr, 1998). Open forests, woodlands, especially near rivers, wetlands; rainforest fringes (Pizzy and Knight, 2012).	Unlikely. No records are known from the Pilbara and not within the range of the species known distribution (BirdLife International 2022, TSSC 2015).
<i>Falco hypoleucos</i>	Grey Falcon	VU	VU	Mainly lightly wooded and coastal riverine flats (Johnstone and Storr, 1998). Lightly treed and inland plains; gibber deserts, sandridges, pastoral lands, timbered watercourses; seldom in driest deserts (Pizzey and Knight, 2012).	Likely. The Survey Area is potentially suitable foraging habitat. Listed by EPBC as Known to Occur in the feature area and five records since 2012 occur near the Turner River and larger tributaries. The closest record is 9 km west of the Survey Area. All habitats in the Survey Area are suitable foraging habitat for this species.
<i>Falco peregrinus</i>	Peregrine Falcon	OS	-	Mainly about cliffs along coasts, rivers and ranges, and about wooded watercourses and lakes (Johnstone and Storr, 1998). Cliffs, gorges, timbered watercourses, environs of rivers, wetlands, plains, open woodlands, pylons, spires, buildings (Pizzey and Knight, 2012).	Possible. No suitable nesting habitat. All habitats are suitable for foraging. Local records occur nearer to the rocky range habitats, 10 km or more to the east and southwest.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
<i>Glareola maldivarum</i>	Oriental pratincole	MI	MI	<p>Feeding in air and roosting on bare ground beside water, e.g. tidal flats and floodwaters (Johnstone and Storr, 1998).</p> <p>Plains; shallow wet and dry edges of open bare wetlands; tidal mudflats, beaches (Pizzey and Knight, 2012).</p>	<p>Unlikely. Sandy substrates indicate limited pooling of water in the ephemeral drainage lines and run-on areas. No Permanent pools.</p> <p>No records in the local area. PMST considers the species May occur.</p>
<i>Hirundo rustica</i>	Barn swallow	MI	MI	<p>Mainly towns and wetlands (sewage and saltworks ponds, river pools, swamps, tidal creeks and reservoirs) (Johnstone and Storr, 2004).</p> <p>Open country; agricultural land, especially near water; railyards, towns, overhead wires (Pizzey and Knight, 2012).</p>	<p>Unlikely. Sandy substrates indicate limited pooling of water in the ephemeral drainage lines and run-on areas. No Permanent pools.</p> <p>No records in the local area. PMST considers the species May occur.</p>
<i>Motacilla cinerea</i>	Grey Wagtail	MI	MI	<p>Mainly banks and rocks in fast-running fresh water habitats; rivers, creeks, streams and around waterfalls, both in forest and open country; but occurs almost anywhere during migration. Flits from rock to rock, and often enters water after insects (or performs flycatcher sallies after them) (Johnstone and Storr, 2004).</p> <p>In Australia, near running water in disused quarries; sandy, rocky streams in escarpments and rainforests; sewage ponds, ploughed fields, airfields (Pizzey and Knight, 2012).</p>	<p>Unlikely. The drainage lines in the Survey Area are highly ephemeral and would only flow for brief period of time. Drainage lines are in plains habitat where fast running channel flow is limited. There are no previous records in the local area and the species is uncommonly recorded in Australia.</p> <p>No records in the local area. PMST considers the species May occur.</p>

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
<i>Motacilla flava</i>	Yellow Wagtail	MI	MI	Damp short-grass flats: rice stubbles and edge of swamps, sewage ponds, bore overflows, grazed or mowed grass and irrigated areas (Johnstone and Storr, 2004).	Unlikely. Sandy substrates indicate limited pooling of water in the ephemeral drainage lines and run-on areas. No Permanent pools. No records in the local area. PMST considers the species Likely to occur.
<i>Pezoporus occidentalis</i>	Night Parrot	CR	EN	Treeless or sparsely wooded spinifex <i>Triodia</i> spp. near water (including artesian bores) (Johnstone and Storr, 1998). Seeding spinifex on stony rises, breakaway country, sandy lowlands; shrubby glasswort, chenopods; succulents on flats around salt lakes; flooded claypans saltbush, bluebush, bassia associations (Pizzey and Knight, 2012).	Possible. No local records. Habitat modelling includes the Survey Area at the extremity of the species potential extent. Foraging resources are limited.
<i>Polytelis alexandrae</i>	Princess parrot	P4	VU	The Princess parrot usually occupies swales between sand dunes and is occasionally seen on the slopes and crests of dunes. This habitat consists mostly of open savannah woodlands with shrubs such as <i>Eremophila</i> spp., <i>Grevillea</i> spp., and <i>Hakea</i> spp., with scattered Eucalyptus or <i>Allocasuarina</i> trees. Some records are from riverine forest, woodland and shrubland.	Unlikely. No records within 30 km. No dune/swale or riverine forest habitats present. Some <i>Grevillea</i> and <i>Hakea</i> available but in low density. Considered May occur in the PMST.
<i>Rostratula australis</i>	Australian Painted-Snipe	EN	EN	Common in south and north-east Kimberley swampy plains before their degradation by cattle, but only five records since 1909. Rare summer visitor to North-west, single birds recorded at man-made ponds in the Hamersley and Ophthalmia Ranges in December and January and a male collected at Carnarvon in November.	Unlikely. No habitat occurs in the Survey Area. Sandy substrates indicate limited pooling of water in the ephemeral drainage lines and run-on areas. No Permanent pools. Vegetation fringing creeks is too open to provide suitable cover.

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		BC Act	EPBC Act		
				<p>In arid interior a female about to lay collected at Brockman Creek in August 1896 (Johnstone and Storr, 1998).</p> <p>Well-vegetated shallows and margins of wetlands, dams, sewage ponds; wet pastures, marshy areas, irrigation systems, lignum, tea-tree scrub, open timber. (Pizzey and Knight, 2012)</p>	No records in the local area. PMST considers the species May occur.
-- Mammals --					
<i>Dasyercus blythi</i>	Brush-tailed Mulgara	P4	-	Inhabits spinifex grasslands and burrows on the flats between low sand dunes (Van Dyck and Strahan, 2008).	<p>Present. Sandy basin habitat is suitable.</p> <p>Multiple database records occur less than 15 km to the south and west.</p>
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	EN	The Northern Quoll will usually den in hollow tree trunks (Hill and Ward, 2010) or in small caves and crevices in rocky outcrops.	<p>Likely. Available denning habitat occurs in the granite overhangs and tree hollows in the riparian vegetation. Foraging and dispersal habitat is available in all habitat types. No evidence of Northern Quoll was recorded during the survey.</p> <p>Confirmed to occur in the Rocky Outcrop Habitats 11 km to the east and the large rivers 7 km to the west. The Survey Area is not within any buffered critical habitat.</p>
<i>Hipposideros stenotis</i>	Northern Leaf-nosed Bat	P2		It is found near the entrance of shallow caves and abandoned mines where they are usually very sensitive to the approach of an observer (Duncan <i>et al.</i> 1999).	Unlikely. Very few records in the Pilbara. Database records from 2012 are a cluster of acoustic recordings, however the location is stated as 'Great Sandy Desert' therefore have low spatial accuracy. The accepted distribution of this

Species	Common Name	Conservation Code		Relevant Habitat Preference	Assessment of Occurrence
		BC Act	EPBC Act		
				It forages in forest, woodlands and grasslands in close proximity to rocky outcrops and escarpments (Churchill 2008).	species does not include the Pilbara region (<i>e.g.</i> , Churchill 2008). Records may be a result of misidentification of echolocation records (Specialised Zoological 2022).
<i>Lagorchestes conspicillatus leichardti</i>	Spectacled Hare-Wallaby	P4	-	Open <i>Acacia</i> forests, open woodlands and tall shrubland over tussock or hummock grasslands (Van Dyck and Strahan, 2008).	Likely. Historic records nearby and recent survey has recorded potential signs (APM 2022b, 2023d). Suitable shelter habitat in the Spinifex Open Plains habitat where the shrub layer has the highest densities.
<i>Macroderma gigas</i>	Ghost Bat	VU	VU	Their distribution is influenced by the availability of suitable caves and mines for roost sites (Churchill 2008). In the Pilbara, ghost bats prefer to forage on productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (<i>Triodia</i> spp.) on sand or stony ground (Bat Call WA 2021a).	Likely. Foraging habitat available across the Survey Area. No roosting habitat available. The Survey Area is within foraging range of previous record locations.
<i>Macrotis lagotis</i>	Bilby	VU	VU	Occupy a variety of inland habitats including grass and stony downs country on cracking clays, desert sandplains and dune fields of laterite with hummock grassland and massive red earths with <i>Acacia</i> shrubland (Van Dyck and Strahan, 2008).	Likely. All habitats are suitable. Recent database records 7 km to the west. No evidence of burrows or foraging therefore any usage of the Survey Area is likely transitory and infrequent.
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse	P4	-	Found on stony hillsides with hummock grassland (Menkhorst and Knight, 2009)	Unlikely. No stony rise habitats.

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<i>Rhinonicteris aurantia</i>	Pilbara Leaf-Nosed Bat	VU	VU	Dependant on deep and complex cave systems. Roosting and foraging habitats defined by TSSC (2016) and Bat Call WA (2021b)	Likely. No roosting habitat available. Priority 4 and 5 foraging habitat is present.
<i>Sminthopsis longicaudata</i>	Long-tailed Dunnart	P4		A specialist rock dwelling species (Freeland <i>et al.</i> 1988). It prefers exposed rock and stony soils with hummock grasses and shrubs, on flat-topped hills, lateritic plateaus, sandstone ranges and breakaways.	Unlikely. No suitable habitat.
-- Reptiles --					
<i>Anilius ganei</i>	Gane's blind snake (Pilbara)	P1		Known from widely separated areas between Newman and Pannawonica. Possibly associated with moist gorges and gullies (Wilson and Swan 2008).	Unlikely. Suitable habitat unlikely to be present as drainage lines are small and highly ephemeral.
<i>Liasis olivaceus</i> subsp. <i>baronni</i>	Pilbara Olive Python	VU	VU	Recorded in areas with gorges and escarpments in close proximity to water holes (Doughty <i>et al.</i> 2011). During the cooler months they will typically hide in caves, crevices and fissures away from water sources. However, in the warmer months they become active and tend to stay near rocky outcrops and water.	Present. Recorded on camera using a termite mound. There are no gorges or significant water filled gullies in the Survey Area. No permanent or semi-permanent pools in the creeks. Caves, crevices or fissures are limited to a small area that has no proximity to permanent pools. Suitability of habitat in the Survey Area does not conform to the currently understood habitat preferences.
<i>Liopholis kintorei</i>	Great Desert Skink		VU	A nocturnal burrowing and social lizard, living in family groups and creating extensive burrows that are typically 1 m deep and up to 10 m in diameter with multiple entrances (McAplin 2001).	Unlikely. No records in the local area. PMST considers the species May occur in the buffer area only. The area where suitable habitat may occur is 15 km to the east of the Survey Area and separated by a rocky range.

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		BC	EPBC		
		Act	Act		
				Typically occupy hummock grass sandplains and some adjacent dunefield swales, though they can occur in a variety of habitats (McAplin 2001). Vegetation usually consists of hummock grassland (<i>Triodia basedowii</i> , <i>T. pungens</i> and <i>T. schinzi</i>), with some scattered shrubs and occasional trees (e.g. <i>Acacia</i> spp., <i>Eucalyptus</i> spp., <i>Hakea</i> spp., <i>Grevillea</i> spp. and <i>Allocasuarina decaisneana</i>) (McAlpin 2001). Tend to utilise areas of habitat that have been burnt within the previous 2-15 years (McAplin 2001; Morre <i>et al.</i> 2015).	

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